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Mr. Ross del Rosario
USEPA Region 5 – SR-6J
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March 12, 2012
(2034)

RE: Administrative Order on Consent
Response to USEPA Comments on Site-Specific Work Plan, Revision 1
North Station Upland Operable Unit, North Branch Site, Chicago, Illinois
Peoples Gas Light and Coke Company

CERCLA Docket No. V-W-08-C-917
CERCLIS ID – ILD982074775

Dear Mr. del Rosario,

On behalf of Integrys Business Support, LLC (IBS), Natural Resource Technology, Inc. (NRT) is providing the enclosed two hard copies of replacement pages and two CD copies of the entire Site-Specific Work Plan (SSWP), Revision 1 Modified on March 12, 2012 for the Peoples Gas Light and Coke Company's (PGL) North Station Upland Operable Unit (OU) of the North Branch Site. These documents have been prepared as required in Section 1.1.2.2 of the Statement of Work (SOW) included with the Settlement Agreement and Administrative Order on Consent (Settlement Agreement) between United States Environmental Protection Agency (USEPA) and PGL effective October 31, 2008.

The enclosed modified documents have incorporated USEPA comments received on January 26, 2012 on the SSWP, Revision 1. For ease of review, historic comments are presented below in *italics*, followed by the current responses from IBS.

General Comments

USEPA General Comment #2 - Data Tables Screening Criteria: *The source of the Residential screening criteria is not indicated, and should be provided. As with the agreed upon approach utilized for the Waukegan North Plant SSWP, the most recent EPA RSL tables should be used for data comparison purposes. If necessary, the data should be re-screened against the RSL criteria, and the tables should be updated. Some differences in screening criteria were noted between the Waukegan North Plant SSWP (dated June 30, 2011) and this Completion report, such as the screening criteria used for ethylbenzene and naphthalene. Screening criteria should be consistent between sites. No other footnotes or legend key is shown on the Tables other than "surface" or "floor" sample designations. Footnotes, keys and legends should be used to define abbreviations, etc.*

11/28/11 IBS FOLLOWUP RESPONSE: *Figures 7, 28 and 31, and appendices E1 and H have been modified to include the carcinogenic Regional Screening Levels (RSL) for naphthalene and ethylbenzene. In addition, the historic data summary in Section 3.7 has been updated to include comparison to these carcinogenic RSLs and a reference to the revised SLs is included in Section 4.3.*

1/26/12 USEPA FOLLOWUP COMMENT: *The IBS response is acceptable with the caveat that Table D-1 also be amended to include the residential carcinogenic screening criteria and summary statistics for naphthalene. The table currently shows only the non-carcinogenic criteria.*

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3/12/12 IBS FOLLOWUP RESPONSE: Table D-1 has been modified to include the cancer endpoint screening level for naphthalene for residential soil, 3,600 ug/kg. Summary statistics related to the screening level have also been modified. Hard copies of Tables D-1 and D-2 are attached for replacement in the document. Table D-2 has not been modified, however it was printed on the back of Table D-1 in Revision 1 of the document, so replacement of both tables is necessary.

1/26/12 USEPA Additional Comment *- Per our recent discussions regarding the Division Street Preliminary RI Results, the procedure for evaluating field duplicate results (i.e. data review, validation, data usability, data assessment and corrective action responses) does not appear to be specified in the Multi Site FSP document (dated 9/8/2008), or the Multi Site QAPP (dated 9/4/07). In addition, the North Station Site-Specific QAPP document (Appendix B1 of the submittal) does not contain any discussion of field duplicate evaluation either. Revisions to one or more of these documents are requested to describe the procedures that will be used for the evaluation and use of all field duplicate data. This request is made to clarify the procedures that will be followed if any future discrepancies arise that are similar to the issue that was discovered at Division Street monitoring well location MW -110.*

3/12/12 IBS FOLLOWUP RESPONSE: The groundwater sample duplicate issue identified in the Division Street preliminary data set has been investigated per the Multi-Site QAPP and Site-Specific QAPP. The cause of the apparent disparity between the investigative and duplicate samples originally attributed to well MW-110 was due to an error in transcription of field data to the electronic database. As field notes describe, the duplicate sample was collected at well MW-101, not well MW-110. This correction has been made in the database and tables and figures associated with Division Street.

Consistent with the response to USEPA's comment letters for Division Street and North Plant, as a further corrective action regarding the duplicate issue, IBS will perform a final QC check of all data files created by field contractors prior to uploading duplicate sample data into the database. Electronic files will be verified by comparison to field notes.

Uniform Federal Policy (UFP) QAPP Worksheet #28 is attached to describe evaluation of field duplicate results for aqueous and non-aqueous media in the IBS Multi-Site Program. The approach outlined in the worksheets is based on the Multi-Site QAPP Table 6, the *EPA Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, Revised* (USEPA, December 1996), and an email from Ross del Rosario (USEPA) to Naren Prasad (IBS) on January 24, 2012, titled "Sample Duplicate Discrepancies."

The modified hard-copy documents enclosed should replace Tables D-1 and D-2 of the SSWP, Revision 1 (November 28, 2011). The modified CDs enclosed contain the entire SSWP, Revision 1, modified on March 12, 2012. Please contact Mr. Naren Prasad of IBS at 312.240.4569 if you should have any questions regarding the content of this letter.

Sincerely,

NATURAL RESOURCE TECHNOLOGY, INC.

Sarah Meyer
Senior Scientist/Project Manager

Jennifer M. Kahler, PE
Senior Engineer

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Enc: Modified Table D-1 and original Table D-2 (hard copy replacement pages for SSWP, Revision 1)
Multi-Site QAPP Addendum, UFP QAPP Worksheet #28
SSWP, Revision 1, Modified March 12, 2012 (on CD)

cc: Mr. D. Wilson, IEPA
Mr. Naren Prasad, IBS
Mr. David Klatt, CH2MHill

MULTI-SITE QAPP ADDENDUM
UFP QAPP WORKSHEET #28

QC Samples Table

Matrix	Aqueous and Non-Aqueous
Analytical Group	VOCs/SVOCs
Concentration Level	All
Sampling SOP	SAS-08-02/SAS-06-01
Analytical Method/ SOP Reference	SW846 8260/8270
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
No. of Sample Locations	TBD

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field duplicate (aqueous)	1 in 10 investigative samples, unless otherwise specified	NA	Estimate (J) positive values	Project manager, with data validator and laboratory manager, as needed	Calculate RPD for compounds detected at concentrations ≥ 2x the quantitation limit (QL)	RPD<30%, per Multi-Site QAPP Table 6 and Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, Revised (USEPA, December 1996)
			Use professional judgement to accept, qualify or reject positive detects for the compound. If data is rejected, location may be re-sampled.		Calculate RPD for compounds detected at concentrations ≥ QL and < 2x QL	
Field duplicate (non-aqueous)	1 in 20 investigative samples, unless otherwise specified		Estimate (J) positive values		Calculate RPD for compounds detected at concentrations ≥ 2x QL	
			Use professional judgement to accept, qualify or reject positive detects for the compound. If data is rejected, location may be re-sampled.		Calculate RPD for compounds detected at concentrations ≥ QL and < 2x QL	

QC Samples Table

Matrix	Aqueous and Non-Aqueous
Analytical Group	Inorganics
Concentration Level	All
Sampling SOP	SAS-08-02/SAS-06-01
Analytical Method/ SOP Reference	SW846 6020/7471A/ 9012A/OIA 1677
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
No. of Sample Locations	TBD

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field duplicate (aqueous)	1 in 10 investigative samples, unless otherwise specified	NA	Estimate (J) positive values	Project manager, with data validator and laboratory manager, as needed	Calculate RPD for compounds detected at concentrations ≥ 5x the quantitation limit (QL)	RPD<30%, per Multi-Site QAPP Table 6 and Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, Revised (USEPA, December 1996)
					Calculate absolute difference for compounds detected at concentrations < 5x QL	
Field duplicate (non-aqueous)	1 in 20 investigative samples, unless otherwise specified				Calculate RPD for compounds detected at concentrations ≥ 5x QL	
					Calculate absolute difference for compounds detected at concentrations < 5x QL	

QC Samples Table

Matrix	Aqueous and Non-Aqueous
Analytical Group	PCBs
Concentration Level	All
Sampling SOP	SAS-08-02/SAS-06-01
Analytical Method/ SOP Reference	SW846 8081
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
No. of Sample Locations	TBD

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field duplicate (aqueous)	1 in 10 investigative samples, unless otherwise specified	NA	Estimate (J) positive values	Project manager, with data validator and laboratory manager, as needed	Calculate RPD for compounds detected at concentrations ≥ 2x the quantitation limit (QL)	RPD<30%, per Multi-Site QAPP Table 6 and Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, Revised (USEPA, December 1996)
			Use professional judgement to accept, qualify or reject positive detects for the compound. If data is rejected, location may be re-sampled.		Calculate RPD for compounds detected at concentrations ≥ QL and < 2x QL	
Field duplicate (non-aqueous)	1 in 20 investigative samples, unless otherwise specified		Estimate (J) positive values		Calculate RPD for compounds detected at concentrations ≥ 2x QL	
			Use professional judgement to accept, qualify or reject positive detects for the compound. If data is rejected, location may be re-sampled.		Calculate RPD for compounds detected at concentrations ≥ QL and < 2x QL	

SMARTER SOLUTIONS

EXCEPTIONAL SERVICE

VALUE

Site-Specific Work Plan, Revision 1
North Station Former MGP
North Branch Operable Unit, Chicago, IL
Peoples Gas Light and Coke Company

Modified - March 12, 2012

Project Number: 2034

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SITE-SPECIFIC WORK PLAN

PEOPLES GAS LIGHT AND COKE COMPANY
NORTH STATION FORMER MGP, NORTH BRANCH OPERABLE UNIT
CHICAGO, ILLINOIS

CERCLA Docket No. V-W-08-C-917
CERCLIS ID – ILD982074775

Project No. 2034

Prepared For:

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Revision 1
Modified - March 12, 2012

Sarah L. Meyer
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ABBREVIATIONS / ACROYNMS

ASTM	American Standard Test Method
AOC	Administrative Order on Consent
ARA	Adjacent River Area
ARAR	Applicable or Relevant and Appropriate Requirement
Barr	Barr Engineering Company
BERA	Baseline Ecological Risk Assessment
Bgs	Below Ground Surface
BLRA	Baseline Risk Assessment
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
B&McD	Burns & McDonnell
CCD	Chicago City Datum
cm/s	Centimeters Per Second
CERCLA ("Superfund")	Comprehensive Environmental Response, Compensation and Liability Act
CDOT	Chicago Department of Transportation
C.M.St.P&P	Chicago, Milwaukee, St. Paul & Pacific Railroad Track
ComEd	Commonwealth Edison Company
CID	Construction and Demolition Debris
COPC	Constituent of Potential Concern
CSM	Conceptual Site Model
	Cubic Yards
CWG	Carbureted Water Gas
DOE	Department of Environment
DGPS	Differential Global Position System
DCM	Dichloromethane
DQO	Data Quality Objectives
DRO	Diesel Range Organics
EcoCAT	Ecological compliance assessment tool
ESRI ARCGIS	Economic and Social Research Institute Aeronautical Reconnaissance Coverage Geographic Information System
EDR	Environmental Data Resources, Inc.
°F	Degrees Fahrenheit
FIRM	Flood Insurance Rate Map
FOIA	Freedom of Information Act
FS	Feasibility Study
FSP	Field Sampling Plan
ft	Foot
	Cubic Feet
GC/FID	Gas Chromatograph/Flame Ionization Detector
GC/MS	Gas Chromatograph/Mass Spectrometer
GRO	Gasoline Range Organics
HASP	Health and Safety Plan
HDPE	High-Density Polyethylene
HVAC	Heating, Ventilation, and Air Conditioning
HAARGIS	Historic Architectural/Archaeological Resources
HSA	Hollow-Stem Auger

IDNR	Illinois Department of Natural Resources
IDPH	Illinois Department of Public Health
IDOT	Illinois Department of Transportation
Illinois EPA	Illinois Environmental Protection Agency
Integrys	Integrys Business Support, LLC
IRAP	Interim Response Action Plan
LL	Liquid Limit
LUST	Leaking Underground Storage Tank
MWRD	Metropolitan Water Reclamation District of Greater Chicago
mg/kg	Milligrams per Kilogram (PPM)
MGP	Manufactured Gas Plant
mgd	Million Gallons per day
mL/min	Milliliters per Minute
NAPL	Non-Aqueous Phase Liquid
NRT	Natural Resource Technology, Inc.
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFR	No Further Remediation
The River	North Branch of the Chicago River
O&M	Operation and Maintenance
OSR	Off-Site Rule
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCA	Physical Characterization Assessment
PCB	Polychlorinated Biphenyl
PGL	The Peoples Gas Light and Coke Company
PID	Photoionization Detector
PL	Plastic Limit
PI	Plasticity Index
PNA	Polynuclear Aromatics
PDF	Portable Document Format
PP	Priority Pollutant
PPM	Parts per Million (mg/kg)
PVC	Polyvinyl Chloride
PVOC	Petroleum Volatile Organic Compound
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RAF	Risk Assessment Framework
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation and Feasibility Study
ROR/RAP	Remediation Objectives Report / Remedial Action Plan
RI	Remedial Investigation
ROW	Right-of-Way
RSL	Regional Screening Level
SI	Site Investigation
SRP	Site Remediation Program
SL	Screening Level
SOP	Standard Operating Procedure
SOW	Statement of Work
SFHA	Special Flood Hazard Area

SPLP	Synthetic Precipitation Leaching Procedure
SSI	Supplemental Site Investigation
SSWP	Site-Specific Work Plan
STAT	STAT Analysis Corporation
SVOC	Semivolatile Organic Compound
TACO	Tiered Approach to Corrective Action Objectives
TAL	Target Analyte List
	Tar-specific Green Optical Screening Tool
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
40 CFR 300	Title 40 of the Code of Federal Regulations, Part 300
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
ug/kg	Microgram per kilogram
ug/L	Microgram per liter
UST	Underground Storage Tank
USEPA	United States Environmental Protection Agency
UP	Utility Pole
USGS	United States Geological Survey
VOC	Volatile Organic Compound

1 INTRODUCTION

1.1 Overview

This Site-Specific Work Plan (SSWP) describes procedures and tasks necessary to complete the Remedial Investigation and Feasibility Study (RI/FS) at the North Station Operable Unit (OU) of the North Branch Site in accordance with Administrative Order on Consent (AOC) and Statement of Work (SOW), Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Docket No V-W-'08-C-917, effective October 31, 2008. The AOC/SOW addresses four former Manufactured Gas Plants (MGPs) operated by The Peoples Gas Light and Coke Company (PGL). Under the AOC/SOW, a generic approach was developed to address the four MGPs (i.e., the multi-site approach), which has and will be modified for site-specific differences among locations. The North Branch Site encompasses three Operable Units OUs:

- Division Street Station OU;
- Willow/Hawthorne OU; and
- North Station OU.

Each of the OUs includes a) former MGP operations which occurred on an upland area and b) an adjacent area within the North Branch of the Chicago River (the River). The location of the North Station OU (the OU) is shown in Figure 1.

A Completion Report (Natural Resource Technology, Inc. [NRT], June 2011) describes the substantial investigations and response actions previously performed within the North Station OU. This SSWP builds upon previously collected data and was prepared in accordance with applicable federal statutes and regulations, including the CERCLA ("Superfund"), 42 U.S.C. 9601, et seq., and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), contained in Title 40 of the Code of Federal Regulations, Part 300 (40 CFR 300).

1.2 Objectives

MGP residuals were identified within and around former MGP structures, in adjacent subsurface soil and within sediments in the adjacent river area (ARA), i.e. the portion of the River adjacent to the OU.

Remediation was performed in selected areas through excavation and removal of affected soil. In addition, a slurry wall was installed upgradient of an excavated portion of the OU to reduce the potential for migration of tar onto the remediated area. MGP residuals remain in the soil, groundwater and river sediment that have not been sufficiently delineated.

The area of the North Station OU has been expanded from the previously defined boundaries in the Completion Report. Further review of historical MGP operations identified an additional property that was owned by PGL where MGP byproducts had been handled, as described in Section 2.1. Additional evaluation of this parcel is addressed herein.

This SSWP specifies the procedures for identifying and evaluating the nature and extent of MGP residuals in soil, groundwater, and soil vapor in the upland portion of the OU and in the river sediment and surface water. The data collected will be used to perform a Baseline Risk Assessment (BLRA) that will evaluate the North Station OU risks to human health and the environment. A Feasibility Study (FS) will also be prepared to develop and evaluate remedial alternatives.

2 NORTH STATION OU BACKGROUND AND SETTING

2.1 OU Description and Current Conditions

The North Station OU is comprised of the upland area upon which MGP operations occurred as well as portions of the North Branch of the Chicago River in which MGP residuals occur in sediments. The individual parcels that collectively comprise the North Station OU are shown on Figure 2 and include the following:

- Commonwealth Edison Company (ComEd) parcel – An approximately 5.5 acre parcel previously owned by PGL where the MGP operations and structures occurred.
- LaSalle-Chestnut parcel – An approximately 1.5 acre parcel previously owned by PGL which was utilized only for coal storage for MGP operations.
- Division-Halsted LLC parcel – An approximately 0.5 acre parcel immediately adjacent to and northwest of the LaSalle-Chestnut which was utilized only for coal storage for MGP operations.
- Kingsbury Street – A 1.2 acre City of Chicago (City) right-of-way (ROW) located between the ComEd and LaSalle-Chestnut and Division-Halsted LLC parcels. The property was a former Chicago, Milwaukee, St. Paul & Pacific (C.M.St.P&P) Railroad track.
- Old Town Village West parcels – Two parcels comprising approximately 0.97 acres that were previously owned by PGL adjacent to the MGP operations. The larger 0.89 acre parcel included the company's pipe storage, pipe galvanizing and office operations, as well as storage/warehouse buildings and a building in which tar appears to have been used. The smaller 0.08 acre Old Town Village West parcel showed no historical evidence of MGP structures or operations.
- Adjacent River Area (ARA) – Segment of the North Branch Canal of the Chicago River adjacent to the upland portions of the North Station OU where MGP residuals occur. Current land uses within the North Station OU include the following:

Parcel ID	Approx. Acres	Current Land Use
ComEd	5.5	Electrical substation
Old Town Village West	1.0	Residential
Kingsbury Street	1.2	Vacated city street
LaSalle-Chestnut	1.5	Vacant land
Division-Halsted	0.5	Storage yard for construction equipment

The OU location and identification information is below:

Facility Location:	Section 4, Township 39 North, Range 14 East Section 32, Township 40 North, Range 14 East Chicago, Illinois Cook County
USEPA ID:	ILD982074775

2.2 North Station OU Former MGP Operations

Precursors to PGL built this facility in 1868 for the production of coal gas. Coal gas production involved heating coal in an airtight chamber (retort) and driving off volatile aromatic hydrocarbons as a gas. The gas was then passed through purifiers to remove impurities such as sulfur, carbon dioxide, cyanide and ammonia. The purifiers used trays and sieves containing lime or hydrated iron oxide mixed with wood chips. The gas was then stored in large pressure relief holders on Site prior to distribution for lighting and heating.

In 1887, production was converted to a carbureted water gas process. This process involved passing air and steam over incandescent coal in a brick-filled vessel to form a combustible gas which was then enriched by spraying a fine mist of oil over the bricks. The gas was then purified and stored in holders prior to distribution. Production of manufactured gas created a number of different by-products and wastes, such as various forms of tar, sludges, coke, ash, wood chips and spent oxide/lime.

The MGP facility was closed in the early 1960s. Former MGP-related structures and pertinent historic features on the ComEd and adjacent parcels are shown on historical Sanborn maps in Appendix A1 and summarized on Figure 3. The primary MGP structures included the following:

- Main gas production and retort buildings;
- Purifying house;
- 1.5 million cubic foot () gas holder;
- Two 500,000 relief holders;
- 750,000-gallon oil tank as well as underground oil tanks;
- Tar settling wells, tar extractors, and a tar tank;
- Naphtha tank;
- Oil condensers;

- Pumps and scrubbers;
- Ash hopper; and
- Various equipment and storage buildings.

The area that was used for coal storage on the two adjacent parcels along the North Branch of the Chicago River is shown on Figure 3. The 1910 Sanborn map (Appendix A1) shows the Division-Halsted and LaSalle-Chestnut parcels as a 50,000 ton coke shed owned by PGL. Kingsbury Street was formerly occupied by C.M.St.P&P railroad tracks from prior to 1910 to at least 1990.

The 1910 Sanborn map also shows offices and storage buildings on the Old Town Village West parcel as well as a building containing a tar vat that was apparently used for 'pipe dipping.' An adjacent building was identified as a 'Pipe W.Ho.[warehouse].' The building containing the tar vat and the pipe warehouse are not shown on the 1935 Sanborn map and the property is identified as a contractor's equipment yard.

Potential sources of constituents of potential concern (COPC) within the boundaries of the MGP operations that are not MGP related include the following:

- ComEd parcel: Contents of the electrical substation transformers and associated oil transmission infrastructure maintenance.
- LaSalle-Chestnut parcel: Weathered asphalt and road salt observed in fill as well as other potential waste material. The parcel has also been used to store road salt and by a nearby car dealership to store cars.
- Old Town Village West parcel: Former commercial and industrial manufacturing businesses and six underground storage tanks (UST) occurred on this parcel.

Soil and/or groundwater containing residuals related to the former MGP operations were likely encountered on the ComEd parcel within the electrical substation during its construction but no historical information is described in previous reports.

The former Spanjer Bros. property encompassed a 4.4 acre triangular area bordered by Division, Crosby, Hobbie, and Howe Streets and is located immediately upgradient of the OU (Figures 2, 3, and 4). About one acre of the Spanjer Bros. property was formerly owned by PGL and is referred to herein as the Old Town Village West parcel. The Spanjer Bros. property had been previously occupied by various businesses, including a lumber yard, automobile maintenance/repair garages, junkyard, metal and die cutting shop, sign factory and various manufacturing facilities and factories. Eleven USTs were removed from the Spanjer Bros. property between 1996 and 1999:

UST ID#	Size (Gallons)	Contents
1	550	Unknown
2	10,150	Unknown
3	10,150	Unknown
4	10,000	Unknown
5	1,970	Unknown
6	1,970	Unknown
7	1,080	Unknown
8	8,380	Unknown
9	130	Unknown
10	3,000	Unknown
11	8,000	Gasoline

With the exception of UST 11, insufficient information was available to identify the specific contents associated with each UST location. However, six were reported to contain heating oil, three contained gasoline and two had unspecified contents. The UST locations are shown in Appendix K. It appears that six of these USTs were located on the Old Town Village West parcel following the period of PGL ownership. There were no reported releases from any of the USTs (Harding Lawson, 1996; Pioneer, 2002).

A voluntary cleanup (Illinois EPA LPC#: 0316085389) was performed on the Spanjer Bros. property by MCL Companies in conjunction with a real estate development project consisting of 130 residential condos. Illinois Environmental Protection Agency (Illinois EPA) issued no further remediation (NFR) letters following a series of remediations conducted between 2003 and 2005, as described in Section 2.7.3. The remediation included engineered barriers (clay cap, topsoil, concrete barrier/building foundation) and institutional controls (groundwater use restriction).

2.3 Adjacent Properties

Environmental Data Resources, Inc. (EDR) was retained to conduct a search of available environmental records to identify other potential sources of non-MGP related compounds of concern in the immediate vicinity. Portions of the EDR Radius Map Report with Geocheck®, dated May 12, 2011, are included in Appendix A2. The EDR Report provides information on a target property and nearby sites that have the potential for environmental impacts.

The EDR Radius Map Report, other existing reports and Sanborn maps identified potential sources of environmental impairment on neighboring properties that are not related to the former MGP operations. The following potential considerations were identified:

Halsted Parcel

A 'limited Phase II site investigation' was performed on the Halsted parcel, immediately north of the Division-Halsted parcel, on behalf of Centrum Properties (Clayton, 1999). Five USTs were reportedly located on the property (Figure 3):

- Four 15,000 gallon gasoline USTs which had been abandoned and backfilled in 1964 (approximately 15 feet northwest of the southern property boundary); and
- One 6,000 gallon fuel oil UST installed in 1964 below a boiler room (approximately 120 feet northwest of the southern property boundary).

None of these USTs could be located during the Clayton investigation. The Halsted property was later identified as an Illinois Environmental Protection Agency (Illinois EPA) Leaking underground storage tank (LUST) site (#0316246341) in 2004. Based on the submittal of a Corrective Action Completion Report in May 2005, the site received an Illinois EPA NFR letter in June 2005. The NFR letter was not conditioned upon any land use restrictions or controls, except for an institutional control prohibiting groundwater use consistent with the City ordinance.

A historical auto service station (Yellow Black Service Station) was also located on the northern portion of the Halsted property at 1135 N. Halsted (Parcel 17-04-300-001) in 1928. Three gasoline USTs appear on the 1935 and 1950 Sanborn Maps (Figure 3 and Appendix A1). The 1910 Sanborn map also shows this parcel as the Chicago Wood and Coal Co. with a wood/coal storage area along Kingsbury Street.

The 1910 Sanborn map identifies the southern portion of the Halsted property as the Philadelphia & Reading Coal & Iron Co. The property had a storage capacity for 25,000 tons of coal. It appears coal storage continued on the property through 1935.

735 Division Street

This property is located adjacent to the northwest boundary of the OU. The 1910 Sanborn map shows the building stored coal and oil.

1234 N. Halsted Street (Northwest Corner of Halsted and Division Street)

This property is located several hundred feet northwest of the OU and was identified as an Illinois EPA LUST site (#0316245347) in 2003. No further information was available on a possible release. The property is now operated as a Mobil Gas and Mini Mart with five gasoline, diesel and fuel oil USTs (Appendix A2).

2.4 Topographic Maps

Historical topographic maps of the OU parcels and adjacent properties were obtained from EDR for the years of 1901, 1953, 1963, 1972, 1993, and 1997. Copies of the topographic maps are included in Appendix A3. The topographic maps show most of the City of Chicago but provide no details of the North Station OU. The land slopes gently to the southwest toward the ARA at a grade of approximately 0.1%.

2.5 Aerial Photographs

Historical aerial photographs of the area were obtained from EDR for the years of 1952, 1963, 1972, 1984, 1988, 1994, 1999, 2005 and 2006. The aerial photographs are provided in Appendix A4.

The 1952 aerial photograph shows most of the gas holders and associated buildings of the former MGP on the ComEd parcel as they appear in Figure 2. The coal storage pile is visible on the LaSalle-Chestnut and Division-Halsted parcels as well as the C.M.ST.P&P railroad tracks on Kingsbury Street. The MGP operations and coal storage features are no longer present on the 1963 photo. The electrical substation infrastructure appears on the 1972 photo. Commencing in the 1990s, the area around the OU shows gradual redevelopment taking place with changes in land use from commercial/industrial to increasing residential.

The 2006 aerial photograph shows the North Station OU in its current setting. Adjacent and nearby parcels are to be residential, commercial and industrial structures reflecting the current mix of land uses now present in this area. Industrial land uses are located to the west, across the River from the OU.

2.6 Previous Investigation Summary

Site investigations occurred on the North Station OU and adjacent properties since 2001 and are discussed in the Completion Report (NRT, 2011). The objective and scope of soil, groundwater and sediment investigations performed at each parcel and in the ARA are summarized below.

2.6.1 ComEd Parcel

Comprehensive subsurface investigations have been performed on the ComEd property to identify the magnitude and extent of MGP residuals. The scope of these investigations are summarized below. The results and conclusions from these reports are discussed in Section 2.

2001 April, Barr Engineering Company, *Letter Report – Site Investigation and Interim Remedial Action Plan Summary (Draft)*, *Commonwealth Edison Property, Portion of North Station MGP Site, Chicago, Illinois.*

Objective:

Barr was retained by ComEd to identify the potential presence of MGP residuals in soil and groundwater at the northwest corner of the property in anticipation of installing new transformer capacitors. They perform an interim remedial action to accommodate the infrastructure improvements.

Scope:

A total of eleven soil borings and two monitoring wells (MW-1, MW-4) were completed. Sixteen soil samples were collected for analysis of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) including polycyclic aromatic hydrocarbons (PAHs), and phenolics, total metals, and general parameters including cyanide.

Monitoring well MW-1 was installed but was not sampled due to the presence of a thin layer of free-phase product in the well. Groundwater samples were analyzed for VOCs, SVOCs (PAHs and phenolics), total metals and general parameters including nitrogen as nitrate and nitrite, ammonia, sulfate, total sulfide and pH. Three air samples were collected during implementation of the interim response action plan (IRAP).

The interim response action conducted by ComEd is described in Section 1.5.1.

2001 October, Burns & McDonnell, *Site Investigation Event 2 Sampling Data, North Station, Former Manufactured Gas Plant Site, Commonwealth Edison Property, Chicago, Illinois.*

Objective:

Data collected during the Site Investigation Event 2 was compiled in appendix format. The document includes the following: sample location map; summary tables of surface soil, subsurface soil, source material and groundwater analytical results; data evaluation memoranda and data sheets; quality assurance/quality control (QA/QC) data; laboratory case narratives and chain of custody records.

2002 June, Burns & McDonnell, *Site Investigation Event 2 Report*, *North Station, Former Manufactured Gas Plant Site, Commonwealth Edison Property, Chicago, Illinois.*

Objective:

Report on the results of extensive site investigation of the former MGP property performed on behalf of PGL to assess the magnitude and extent of MGP residuals on the ComEd parcel.

Scope:

Performed 63 soil probes and seven soil borings at various locations throughout the property. The investigation was constrained by the presence of numerous active electrical transformers and subsurface electric lines throughout the parcel. Soil samples were collected from various depths and analyzed for target compound list (TCL) VOCs, TCL SVOCs, priority pollutant (PP) metals, total cyanide and amenable cyanide and, in some cases, physical properties. Four soil boring locations were converted to monitoring wells; two soil boring locations were converted to temporary piezometers. In addition, groundwater samples were collected from the wells and piezometers and analyzed for TCL VOCs, TCL SVOCs, PP metals and total cyanide.

2.6.2 LaSalle-Chestnut Parcel

Several phases of investigation have been conducted to assess the extent that historical storage of coal may have impaired the LaSalle-Chestnut parcel. Investigations have also addressed potential migration of MGP residuals from the ComEd property and the potential for several City and ComEd tunnels, sewer lines and related subsurface infrastructure to act as preferential migration pathways for residuals from the MGP operations. The scope of these investigations are summarized below.

Extensive excavation was performed on this parcel to address residential and construction worker exposure routes through the removal of soil to a depth of up to 10 feet below ground surface (bgs). The remediation of this parcel has been completed and is discussed in Section 1.5.2. The nature and extent of post-remediation MGP residuals are discussed in detail in Section 2.

2001 February, Barr Engineering Company, *Letter Report – Site Investigation Summary (Draft)*, *North Station Site, LaSalle-Chestnut Property, Chicago, Illinois*.

Objective:

Site investigations were conducted in December 1999 and November 2000 on behalf of the PGL in anticipation of entering this property into the Illinois EPA Site Remediation Program (SRP). The objectives were to characterize the magnitude and extent of MGP-related constituents beneath the site;

locate below-grade historical structures and assess contents and integrity to the extent possible; assess possible compounds present from non-MGP sources; provide sufficient data to evaluate parameters exceeding residential, commercial/industrial and construction worker scenario remediation objectives.

Scope:

Performed eight soil borings and installed two monitoring wells (MW-2, MW-3). Eight soil samples and two groundwater samples were collected. Soil samples were analyzed for VOCs, SVOCs including PAHs, and phenolics, total metals, toxicity characteristic leaching procedure (TCLP) metals, and general parameters including pH, nitrogen, and cyanide. Groundwater samples were analyzed for VOCs, SVOCs (PAHs and phenolics), total metals and general parameters including pH, nitrogen, cyanide, sulfate, and sulfide.

Based on the presence of MGP-related constituents above remediation objectives in soils and groundwater beneath the site, supplemental site investigation activities were performed in July 2001 (B&McD, June 2006).

2001 November, Burns & McDonnell, *Supplemental Site Investigation Sampling Data, North Station, Site, LaSalle-Chestnut Property, Chicago, Illinois.*

Objective:

Data collected during the Supplemental Site Investigation was compiled in appendix format. The document included the following: sample location map; summary tables of surface soil, subsurface soil and groundwater analytical results; data evaluation memoranda and data sheets; quality assurance/quality control measures; laboratory case narratives and chain of custody records.

2006 June, Burns & McDonnell, *Supplemental Site Investigation Report*, *North Station, LaSalle-Chestnut Property, Chicago, Illinois.*

Objective:

Report on supplemental site investigation activities performed in support of development of remedial action objectives and a remedial action plan.

Scope:

A total of 13 soil probes and 5 soil borings were advanced at various locations across the property. Soil samples were collected from various depths within each soil probe and soil boring. In addition, four surface soil samples were collected by hand from 0 to 6 inches below ground surface. All samples were analyzed for TCL VOCs, TCL SVOCs, PP metals, and total and amenable cyanide.

Three soil boring locations were also converted to 2-inch polyvinyl chloride (PVC) monitoring wells and groundwater samples were collected and analyzed for TCL VOCs, TCL SVOCs, PP metals and total and amenable cyanide.

2006 August, Burns & McDonnell, *Remediation Objectives Report/Remedial Action Plan, North Station, LaSalle-Chestnut Property, Chicago, Illinois.*

Objective:

Evaluate exposure pathways and develop corrective measures to eliminate exposure of residents and construction workers to MGP residuals at the LaSalle-Chestnut property.

Scope:

The report evaluated soil migration to groundwater exposure route; developed site-specific screening levels (SL), evaluated compounds exceeding tier 1 groundwater ingestion SLs compared to surface water quality standards; used the City of Chicago groundwater ordinance as an institutional control to eliminate the groundwater ingestion route; evaluated the Tier 1 residential soil ingestion exposure route and conducted a Tiered Approach to Corrective Action Objectives (TACO) Tier 3 impractical-to-remediate evaluation utilizing the Chicago background PAH concentrations for several PAHs. Based upon plans for future construction and residential use of the property, remediation objectives were established:

Following approval by the Illinois EPA of the Remediation Objectives Report / Remedial Action Plan, response actions were conducted on behalf of PGL in 2007. The response actions are described in B&McD (June 2009) below and in Section 1.5.2.

2006 November, Burns & McDonnell, *Draft-Remedial Action Completion Report, Former North Station Manufactured Gas Plant Site, LaSalle-Chestnut Property, Chicago, Illinois*

Objective:

Presents data from a soil sampling event conducted on August 4, 2006 on the south end of the LaSalle-Chestnut property over a City auxiliary outlet sewer. The work was performed on behalf of PGL.

Scope:

Six borings were performed and thirteen soil samples (3 to 15 foot depths) were analyzed for TCL VOCs, TCL SVOCs, PP metals and cyanide. No report narrative was prepared. The document includes the following in appendix format: sample location map; soil analytical data summary tables; data validation memorandum; laboratory data reports; soil probe logs.

2008 April, Burns & McDonnell, *Interim Remedial Action Summary Report, North Station Former Manufactured Gas Plant Site, Kingsbury Street, Chicago, Illinois*

Objective:

This report describes an interim remedial action performed along Kingsbury Street where MGP residuals were observed seeping along a sidewall during the 2007-2008 excavation/remediation of the LaSalle-Chestnut Property.

Scope:

The interim remedial action included site preparation, installation of a continuous, 285-foot long, subsurface containment wall along Kingsbury Street, off-site disposal of excavated soil, backfilling excavations with clean, imported backfill and ambient air monitoring during remediation activities.

2009 June, Burns & McDonnell, *Remedial Action Completion Report, Former North Station Manufactured Gas Plant Site, LaSalle-Chestnut Property, Chicago, Illinois*

Objective:

This report describes the remedial action activities performed at the LaSalle-Chestnut parcel and presents confirmation sampling results to demonstrate that remediation objectives were met based on residential property use.

Scope:

Remedial action activities included site preparation; waste characterization; ambient air monitoring; excavation, stockpiling, and off-site soil disposal; backfilling; confirmation soil sampling; management of remedial action water waste; site restoration; and demobilization.

2.6.3 Division-Halsted Parcel

Two phases of investigation have been conducted to assess the extent that historical storage of coal and potential migration of MGP residuals from the ComEd property have affected the Division-Halsted parcel. The scope of these investigations are summarized below. The nature and extent of MGP residuals are discussed in detail in Section 2.

1999 November, Clayton Environmental Consultants, *Limited Phase II Environmental Investigation, 1111-1127 North Halsted Street, Chicago, Illinois.*

Objective:

Determine the quality of soil and/or groundwater associated with the presence of on-site USTs and former MGP coal storage as well as off-site MGP and service station operations. The work was performed on behalf of Centrum Properties.

Scope:

Seven borings were performed to a depth of 15 feet. One boring extended to 24 feet with a temporary well installed to collect a groundwater sample. Seven soil and one groundwater samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) and PAHs.

2005 October, Burns & McDonnell., *Site Investigation Sampling Data*, *North Station Former Manufactured Gas Plant Site, Division Halsted LLC Property, Chicago, Illinois.*

Objective:

An initial site investigation was performed on September 12 and 13, 2005 on behalf of PGL on the portion of the property where coal had been stored.

Scope:

Twelve borings were performed. Twelve surface soil samples (0 to 3 foot interval) were analyzed for TCL VOCs, TCL SVOCs, PAHs, TCLP lead, Synthetic Precipitation Leaching Procedure (SPLP) lead, PP metals and cyanide. Sixteen soil samples (4 to 14 foot depths) were analyzed for TCL VOCs, TCL SVOCs, PAHs, TCLP metals, SPLP metals, PP metals and cyanide. One soil sample, described as source material (sample SB09, collected from 4-5 feet bgs) was analyzed for TCL VOCs, TCL SVOCs, PAHs, polychlorinated biphenyls (PCBs), PP metals and cyanide.

Piezometers were installed in three borings. Only one groundwater sample was collected and analyzed for TCL VOCs, TCL SVOCs, PAHs, PP metals and cyanide.

No report narrative was prepared. The document includes the following: sample location map; soil, groundwater and source material analytical data summary tables; soil and groundwater sample data validation memoranda; soil and groundwater analytical data sheets.

Manufactured Gas Plant Site, Division Halsted LLC Property, Chicago, Illinois.

Objective:

Presents data from the site investigation performed September 12 and 13, 2005 to be included in a draft Site Investigation Report (in progress).

Scope:

No report narrative was prepared. The document includes the following: Table 5- total organic carbon (TOC), pH and physical soil analytical results; re-issues the previous surface soil and subsurface soil analytical data summaries as new tables; reissues the previous source material analytical data summaries, plus TOC, reactive cyanide, reactive sulfide, total petroleum hydrocarbons (TPH), flashpoint and pH as new tables; soil boring logs; falling head permeability and Atterberg limit tests (liquid limit [LL], plastic limit [PL] and plasticity index [PI]) on a grey clay sample from SB04 16-18 feet.

2.6.4 Halsted Parcel

As noted previously, the Halsted parcel is located adjacent to the ComEd and Division-Halsted parcels along the North Branch of the Chicago River (Figure 2). Two site investigations have been conducted on this parcel in conjunction with property transfers. The scope of these Phase II investigations also included the Division-Halsted parcel and are summarized below. The site conditions are discussed in detail in Section 2.

1999 November, Clayton Environmental Consultants, Limited Phase II Environmental Investigation, 1111-1127 North Halsted Street, Chicago, Illinois.

Objective:

Determine the presence of soil and/or groundwater affected by on-site USTs and former MGP coal storage as well as off-site MGP and service station operations. Work was performed on behalf of Centrum Properties.

Scope:

Seven borings were performed to a depth of 15 feet at various locations. Borings B-1 and B-6 were performed on the Division-Halsted parcel. One boring (B-2) extended to 24 feet with a temporary well installed to collect a groundwater sample. Seven soil and one groundwater samples were analyzed for BTEX and PAHs.

2011 February, ECS Midwest, *Limited Phase II Environmental Assessment, Red Tail Site # 3, 1127 and 1135 North Halsted & 1124 North Kingsbury, Chicago, Illinois.* ECS Project No. 8325

Objective:

Evaluate whether soil and/or groundwater beneath the Halsted and Division-Halsted parcels have been affected by past site usage. This work was performed on behalf of Red Tail, LLC in follow up to a Phase I conducted on the property.

Scope:

Seventeen soil borings were advanced to approximately 20-feet below grade. Borings SP-5, SP-6, SP-7 and SP-17 were performed on the Division-Halsted parcel. Thirty-four soil samples were collected and analyzed for VOCs, SVOCs, PCBs, pesticides, target analyte list (TAL) metals, cyanide and pH.

Temporary monitoring wells were installed in five of the borings, including SP-5 on the Division-Halsted parcel. Five groundwater samples were analyzed for VOCs, SVOCs, PCBs, pesticides, TAL metals, and cyanide.

2011 March, Sight on Solutions, Inc., *Surveyor's Exhibit, Division-Halsted, LLC – Exchange Parcel #3, 1127 North Halsted Street, Chicago, Illinois*.

Scope:

Land survey performed on behalf of Division Halsted, LLC.

2.6.5 City of Chicago Right-of-Way

The nature and extent of areas exhibiting MGP residuals along City ROWs surrounding the former MGP operations have been defined through the performance of 97 borings. In addition, test pits were performed to locate and sever pipelines between the former MGP and the North Branch of the Chicago River as well as evaluate their contents. The scope of these investigations are summarized below and the findings are discussed in detail in Section 2.

2001 May, Hygieneering, Inc., *Offsite Environmental Soil Investigation Report*, *Former Manufactured Gas Plant Site Commonly Known as North Station, Chicago, Illinois*

Objective:

Determine whether the historical use of the adjacent property resulted in the occurrence of MGP residuals in the City parkways. The investigation was also meant to establish baseline levels of compounds in the parkways to be filed with the City. This report was prepared on behalf of PGL.

Scope:

Thirty-five soil borings (Geoprobe) were advanced to a depth of ten feet in the parkway area of adjacent to the former North Station Site. Borings were advanced every forty feet, except in the areas where underground utilities forced the distance between borings to be adjusted; Collected three soil samples (0"-6", 0'-3', 3' – water table) from each boring for laboratory analysis. The water table was assumed to be at ten feet. The actual collection depth of this sub-surface sample was determined via field screening with a photoionization detector (PID). Analytical parameters for soil samples included BTEX, PAH/polynuclear aromatics (PNA), phenolics, TPH, total Resource Conservation and Recovery Act (RCRA) metals, cyanide, ammonia, pH and total organic carbon.

One groundwater sample was collected for laboratory analysis of the above constituents and total sulfate/sulfide.

2002 July, LFR Levine Fricke, Inc., *Soil Investigation Report – ComEd Crosby River Crossing, Kingsbury, and Hobbie Street*, *Chicago, Illinois*.

Objective:

Assess the potential for MGP residuals in subsurface soil during proposed construction of new underground electrical equipment at ComEd's Crosby River Crossing along Kingsbury and Hobbie Street and under the Chicago River. The boring location plan was based on the probable location of underground excavations.

Scope:

Thirty one borings were performed along Crosby, Hobbie and Kingsbury Streets. Two borings were also performed on the "Dickman's property" (a/k/a LaSalle-Chestnut) west of Kingsbury. Borings were typically 12 feet deep but extended up to 37 feet bgs.

One soil sample from each boring was analyzed for BTEX and RCRA metals. In addition, one composite sample was tested for waste stream characterization.

2003 January, Gas Technology Institute, *Chemical Fingerprinting Analysis of Twenty-four Samples From the People's Energy North Station Site*

Objective:

Identify the chemical nature of the waste, in order to identify its origin. The samples were tested and evaluated against known standards for the presence of pyrogenic substances (tar material), petrogenic substances (crude oil derivatives) and other organic compounds.

Scope:

Chemical fingerprinting analysis of twenty-four soil samples collected from the North Station former MGP site. Soil samples were prepared by solvent extraction (EPA 3570) using dichloromethane (DCM). The extracts analyzed by gas chromatograph/flame ionization detector (GC/FID) (EPA 8100 mod.) and gas chromatograph/mass spectrometer (GC/MS) (EPA 8270mod.).

2003 May, Burns & McDonnell, *Offsite Environmental Supplemental Site Investigation Sampling Data*, *North Station, Former Manufactured Gas Plant, Chicago, Illinois.*

No report narrative was prepared. The document includes the following: sample location map; surface and subsurface soil analytical data summary tables; soil sampling data validation memorandum; soil data sheets and QA/QC.

2003 May, Burns & McDonnell, *Draft-Offsite Environmental Supplemental Site Investigation Report*, *North Station, Former Manufactured Gas Plant, Chicago, Illinois.*

Objective:

Confirm previous investigation data results along the right-of-way surrounding the former MGP; further evaluate the nature and extent of off-site MGP residuals in the parkways and roadways and characterize soil that may be removed during proposed utility construction work performed by ComEd.

Scope:

Thirty-one soil probes were advanced in the parkways and roadways surrounding the ComEd property; five test pits were excavated along the east side of North Kingsbury Street to determine the location and condition of pipe lines between the former MGP and the North Branch of the Chicago River. Soil samples were analyzed for TCL VOCs, PAHs, and PP metals.

2.6.6 Old Town Village West

Additional information was compiled on the former Spanjer Bros. property east of Crosby Street through a FOIA request to Illinois EPA. Several phases of investigation have been conducted to assess the potential impact of former commercial/industrial land uses and USTs that occurred on this parcel. The scope of these investigations is summarized below.

Limited soil excavation and removal was performed on this parcel to facilitate development of the property for residential use. The remediation of this parcel has been completed and is discussed in Section 2.7.3.

1995 June, Revised August 24, 2001, K-Plus Environmental, Inc. *Phase II Environmental Assessment, Spanjer Brothers, Inc. 1160 North Howe, 1165 North Crosby, 645 West Elm, Chicago, Illinois.*

Objective:

Determine the quality of soil and/or groundwater associated with the presence of on-site USTs and former commercial/industrial operations on the property. The work was performed on behalf of Spanjer Brothers and LaSalle National Bank.

Scope:

The investigation included twenty-seven borings within the area bounded by Division, Howe, Crosby and Hobbie Streets. Eleven borings were performed to a depth of 15 feet within the area defined herein as the Old Town Village West parcel. Soil samples were analyzed for VOCs, BTEX, SVOCs and PAHs. Boring logs were not provided in the 2001 revision of this report.

1996 June, Harding Lawson Associates. *Catch Basin/Machine Pit Cleaning and UST Removal, Former Spanjer Brothers Site, Southeast Corner of West Division and North Crosby Street, Chicago, Illinois.*

Objective:

Remove the existing USTs to facilitate demolition of the existing buildings for future development by MCL Companies.

Scope:

Remove liquids from the catch basins/machine pits and USTs and document the removal/disposal of 10 USTs. No samples were collected.

1999 April, Pioneer Engineering and Environmental Services, Inc. *UST Closure Report, Vacant Lot, 1116 N. Howe Street, Chicago, Illinois.*

Objective:

Document a UST removal along the east boundary of the Old Town Village West parcel along Howe Street.

Scope:

An 8,000 gallon gasoline UST was removed along with 2,000 gallons of pumpable liquid which was disposed of by North Branch Environmental at the City of Crest Hill. The Chicago DOE inspector classified the site as 'No Release'.

2001 June, Pioneer Engineering and Environmental Services, Inc. *Phase I Environmental Site Assessment, Southwest Corner of West Division and North Howe Street, Chicago, Illinois.*

Objective:

Identify potential recognized environmental conditions on the property on behalf of LaSalle Bank.

Scope:

Performed an ASTM Phase I Environmental Site Assessment on properties bordered by Division, Howe, Crosby and Hobbie Streets.

2002 April, Pioneer Engineering and Environmental Services, Inc. *Site Investigation Report – Comprehensive, Volumes I and II, Old Town Village West, Southeast Corner of West Division and North Crosby Street, Chicago, Illinois.*

Objective:

Conduct further investigation of the property in response to previously identified recognized environmental conditions and future residential development. The work was performed on behalf of MCL Companies.

Scope:

The investigation included 54 borings within the area bounded by Division, Howe, Crosby and Hobbie Streets. Twenty-four of these borings were performed to a depth of 15 feet within the area defined herein as the Old Town Village West parcel. Three of these borings included installation of groundwater monitoring wells. Soil and groundwater samples were analyzed for TCL VOCs, PAHs and RCRA metals.

The PDF files of soil analytical data summary tables received from the Illinois EPA FOIA request were unreadable. Report figures were also omitted. Boring logs and groundwater analytical data from this report are provided in Appendix K.

2002 August, Pioneer Engineering and Environmental Services, Inc. *Remediation Objectives Report and Remedial Action Plan, Old Town Village West, Southeast Corner of West Division and North Crosby Street, Chicago, Illinois.*

Objective:

Conduct further investigation of the property in response to Illinois EPA comments on the Site Investigation Report, evaluate exposure pathways and develop corrective measures to eliminate exposure of residents to COPCs at the property.

Scope:

Three additional borings were performed to evaluate potential releases from a former UST that contained PCB. The report included Tier 2 soil evaluation, exposure route evaluation and soil ingestion exposure route evaluation. Remedial action objectives were developed and a remedial plan was proposed that included construction of engineered barriers and the development of a Health & Safety Plan to address future construction activities in certain areas of the site.

2004 December. Pioneer Engineering and Environmental Services, Inc. Remedial Action Completion Report, Remedial Site #4

Objective:

Document remedial activities, including soil removal and installation of engineered barriers in support of obtaining an NFR letter.

Scope:

The remediation included the excavation and disposal of 1,410 cubic yards ( ) of soil. The report documents installation of a compacted clay and topsoil barrier in landscaped areas as well as documenting the installation of building concrete floors and pads to eliminate the soil ingestion pathway. This report is attached in Appendix K.

2005 May, Pioneer Engineering and Environmental Services, Inc. *Remedial Action Completion Report, Remedial Site #5, Old Town Village West, Chicago, Illinois.*

Objective:

Document remedial activities, including soil removal and installation of engineered barriers in support of obtaining an NFR letter.

Scope:

The remediation included the excavation and disposal of 975 of soil. The report documents installation of a compacted clay and topsoil barrier in landscaped areas as well as documenting the installation of building concrete floors and pads to eliminate the soil ingestion pathway. This report is attached in Appendix K.

2.6.7 North Branch of the Chicago River

Initial investigations have been conducted in the sediments of the North Branch of the Chicago River adjacent to the former MGP that document the presence of MGP residuals. The investigation performed is discussed below and findings are discussed in Section 3.

2006 November, Burns & McDonnell, *Draft-River Sediment Investigation Summary, Former North Station Manufactured Gas Plant Site, LaSalle-Chestnut Property, Chicago, Illinois.*

Objective:

Evaluate the presence of MGP residuals in the North Branch of the Chicago River adjacent to the LaSalle-Chestnut and Division-Halsted properties. The investigation was completed on behalf of PGL.

Scope:

No data analysis or report narrative was prepared. Thirty-three Tar-specific Green Optical Screening Tool (TarGOST) probes were conducted in October 2006. Probe depths ranged from about 20 to 30 feet. The report provides a sample location map and TarGOST probe logs.

2007 April, Burns & McDonnell, Draft-*River Sediment Investigation Summary, North Station Former Manufactured Gas Plant Site, Chicago, Illinois.*

Objective:

Evaluate the presence of MGP residuals in the North Branch of the Chicago River adjacent to the LaSalle-Chestnut and Division-Halsted properties. The document presents a sample location map and compiles data from for the investigation completed on behalf of PGL.

Scope:

No data analysis or report narrative was prepared. The document provides a revised sample location map; re-issues the same 33 TarGOST probes conducted in October 2006 plus logs for three hollow-stem auger borings in North Branch of the Chicago River sediment in March 2007; two photos showing visual evidence of tar; Environmental Forensic Report (Meta Environmental, Inc., March 28, 2007) with results of three sediment samples analyzed by GC/FID for fingerprinting and by GC/MS/selected ion monitoring (SIM) for mono- and polycyclic aromatic hydrocarbons, alkyl PAH homologues and other selected compounds.

2.6.8 Quality of Existing Data

For those data collected by parties other than People's Gas Light and Coke Company, an assessment of data quality is summarized below:

- 1999 November, Clayton Environmental Consultants, *Limited Phase II Environmental Investigation, 1111-1127 North Halsted Street, Chicago, Illinois.* A full data package was provided in the report indicating that SW846 methods were used for sample analysis. Case narrative and quality control results are also included. No obvious failures in analytical procedures were identified. Data quality is presumed to be acceptable.

- 2001 April, Barr Engineering Company, *Letter Report – Site Investigation and Interim Remedial Action Plan Summary (Draft)*, *Commonwealth Edison Property, Portion of North Station MGP Site, Chicago, Illinois.* No laboratory data reports were provided for this work, only data tables. The report references the fact that the investigation was completed in accordance with an approved work plan and laboratory quality assurance manuals for Test America Laboratories, Inc. and Stat Analysis Corporation. Data quality is presumed to be acceptable.

- 2002 July, LFR Levine Fricke, Inc., *Soil Investigation Report – ComEd Crosby River Crossing, Kingsbury, and Hobbie Street*, *Chicago, Illinois*. A full data package was provided in the report indicating that SW846 methods were used for sample analysis. Case narrative and quality control results are also included. No obvious failures in analytical procedures were identified. Data quality is presumed to be acceptable.

- 2011 February, ECS Midwest, *Limited Phase II Environmental Assessment, Red Tail Site # 3, 1127 and 1135 North Halsted & 1124 North Kingsbury, Chicago, Illinois.* ECS Project No. 8325. A full data package was provided by Test America Laboratories, Inc., indicating that SW846 methods were used for sample analysis. Case narrative and quality control results are also included. No obvious failures in analytical procedures were identified. Data quality is presumed to be acceptable.

- 2002 April, Pioneer Engineering and Environmental Services, Inc. *Site Investigation Report – Comprehensive, Volumes I and II, Old Town Village West, Southeast Corner of West Division and North Crosby Street, Chicago, Illinois.* A full data package was provided in the report indicating that SW846 methods were used for sample analysis. No obvious failures in analytical procedures were identified. Data quality is presumed to be acceptable.

2.7 Previous Response Actions

Remedial actions within the OU have been conducted on the ComEd and LaSalle-Chestnut parcels. Due to the limitations posed by the operating electrical substation, remedial measures performed on the ComEd property have been associated with the construction of additional substation infrastructure. As noted above, the remedial action performed on the LaSalle-Chestnut parcel involved extensive soil excavation intended to be a final remedy. These activities are described below.

2.7.1 ComEd Parcel

ComEd intended to install new transformer capacitors on the northwest portion of on the property where potential former MGP structures existed. Interim response actions were conducted by PGL at the request of ComEd (Barr, September 1999). The overall objective of the interim remedial action was to remove MGP soils and historical structures from the footprint of the proposed capacitor bank location.

The interim remedial action was conducted in December 1999 and consisted initially of placing pilot borings in an area delineated by ComEd as the site of their future capacitor bank. The borings determined the nature and extent of soil materials exhibiting MGP residuals at the location as well as the existence of potential underground structures (Figure 5). The former capacitor bank foundations present at the location were removed and the delineated area was then excavated to a depth of approximately 4.5 feet bgs. According to ComEd, this excavation depth allowed for future placement of suitable base materials underneath the planned capacitor bank foundations.

Most of the excavated material was gravelly clay and clayey fill with some traces of wood, brick, concrete and metal debris. The upper 3 to 4 feet of the area were more gravelly with sandy clay and crushed rock fill. The excavation interval of 3 feet bgs to the total excavated depth of 4.5 feet showed visible signs of oily coal tar (free phase) and coal tar residuals. The coal tar residuals appeared to be mainly associated with perched water present at the top of clayey fill (3 to 4 feet bgs). Numerous concrete foundations and piers were also removed, as well as wood and galvanized piping materials and a crushed, buried galvanized steel tank approximately 20 feet long by 8 feet in diameter.

The excavated area formed a rectangle approximately 36 feet by 67 feet. A total soil volume of approximately 420 (in-situ measurement) was removed during this phase of the remedial action. The remedial action contractor placed removed materials in roll-off boxes which were stored on site prior to characterization and transported off site for disposal at a Clean Harbors, Inc. facility. Subsequent characterization of these materials showed that they were not hazardous waste.

Since part of the excavation was below the perched water table, a total of 5,864 gallons of water was removed to facilitate excavation to the desired depth. Water was stored onsite in two tanks and characterized for offsite disposal by Clean Harbors, Inc.

The excavation backfill included a base of crushed rock (Illinois Department of Transportation [IDOT] CA-6) and then gravel (CA-1) to a finish grade within the excavated area of 3 feet below the original site grade. A total of 308 tons of fill materials were placed and compacted in anticipation of further site activities. A new set of capacitor banks has since been installed at the excavated location.

Air sampling was conducted during the remediation activities to assess potential MGP residuals during the interim remedial action. Three air samples were analyzed for benzene, naphthalene, coal tar pitch volatiles, and phenol. The results indicated no detections for any of the analyzed compounds.

Subsequent remediation activities were conducted solely by ComEd at two additional areas (Figure 6). Approximately 1,100 of additional soil materials were reportedly excavated. Information on these remedial activities was not reported as part of the interim response actions conducted by Barr (September 1999).

ComEd reported that they performed additional soil removal in the fall of 2002 for installation of conduits and cables at various locations on the property. Removal depths or observations during excavations were not reported. Approximate locations of the excavated areas are shown on Figure 6.

2.7.2 LaSalle-Chestnut Parcel

2.7.2.1 Remediation Objectives

Investigation activities conducted at the LaSalle-Chestnut parcel indicated that soils exceeded Illinois EPA residential, construction worker and soil migration to groundwater Tier 1 SLs for one or more compounds. In addition, groundwater at the property exceeded Illinois EPA Class II groundwater ingestion Tier 1 SLs for benzene and naphthalene. However, under Tier 2 R26 evaluations, it was determined that these constituents did not impact the adjacent North Branch of the Chicago River.

The intent of the corrective action was to achieve remediation objectives that would obtain a comprehensive NFR letter from Illinois EPA, based on residential property use. The Illinois EPA-approved *Remediation Objectives Report / Remedial Action Plan* (ROR/RAP) established the following remediation objectives:

- Eliminate the residential soil ingestion exposure route by removing all surface soil (0 to 3 feet bgs);
- Eliminate the residential soil ingestion exposure route by removing subsurface soil (from 3 to 10 feet bgs) that exceeds remediation objectives for benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene. and indeno(1,2,3-cd)pyrene;
- Eliminate the construction worker soil inhalation exposure route by removing subsurface soil (from 3 to 10 feet bgs) that exceeds the remediation objective for naphthalene; and
- Eliminate the groundwater ingestion exposure route through use of the City of Chicago groundwater ordinance in accordance with 35 IAC, Part 742.1015.

Remedial action activities were completed during August 2006 through March 2007 and are described in detail below.

2.7.2.2 Excavation, Stockpiling, Off-Site Disposal of Soil and Backfilling

The property was divided into excavation areas prior to commencement of field activities as shown in Figure 7. Remedial activities consisted of excavating soil on the property to depths ranging from approximately 4 to 10 feet bgs, with a maximum depth of 12 feet bgs in one area. The riverbank was excavated to 10 feet bgs, measured from the level top of the riverbank, in excavation areas A29R, A31R, A33R and A35R. The remaining riverbank areas were excavated to one foot below the water table, which was to a depth of approximately 10 feet below the top of the riverbank. In accordance with ComEd restrictions, utility pole (UP) areas UP1 and UP2, which surround three pairs of 70-foot tall utility poles, were excavated to a depth of 5 feet bgs, in order to preserve the integrity of the poles. Excavations were also restricted by the presence of subsurface structures at shallow depths in some areas over the MWRD deep tunnel structure and City outfall sewer.

Soil removed from the excavations was transported to the Waste Management construction and demolition debris (CID) Soil Bio-Remediation Facility in Chicago, Illinois and disposed of as special waste. The volume of material that was managed and disposed of as special waste was 35,024.62 tons. Decontamination water, excavation water, and accumulated storm water was pumped into an on-site holding tank for disposal at the Orteck facility in McCook, Illinois. During the course of the remedial action, 55,700 gallons of waste water were transported for disposal.

2.7.2.3 Interim Remedial Action - Kingsbury Street Containment Wall

In response to observation of coal tar residuals along an excavation sidewall along Kingsbury Street, a continuous, 285-foot long, subsurface containment wall was installed to prevent MGP residuals from migrating onto the LaSalle-Chestnut parcel. The containment wall location is shown on Figure 7. A 2 to 3-foot wide trench was excavated in 12-foot sections to a depth between 5.5 feet and 6 feet bgs. Silty clay was present at this depth, and the trench was further excavated to a maximum depth of 7.5 feet bgs. A flexible, 20-mil thick, high density polyethylene (HDPE) membrane liner was then installed that extended to the bottom of the excavation with a minimum 1.5 feet lying across the floor of the excavation. The liner was overlapped a minimum of one foot at each abutting 12-foot section. Chicago Department of Transportation (CDOT)-specified flowable fill with no fly ash component was used in the containment wall construction. The excavation was backfilled with this flowable fill to approximately 3 feet bgs. An additional continuous 4-foot long section of wall was constructed perpendicular to the containment wall at the north and south ends.

In the ComEd easement section of Kingsbury Street, the containment wall was constructed around two concrete electrical duct packs. Excavation was completed in this section by means of hydro-excavating the surrounding fill material away from the concrete surface. Flowable fill was placed in the excavation around the duct packs and overlapped with the north and south section of the containment wall previously installed. No HDPE liner was installed around the duct packs. The top of the trench was backfilled with IDOT CM-6 from 0 to 3 feet bgs and compacted.

An ambient air monitoring program for and total VOCs indicated that the containment wall installation activities did not affect air quality in the vicinity of the remediation activities.

2.7.2.4 Confirmation Soil Sampling

Confirmation soil samples were collected on the floor of each excavation area (generally 40 feet by 40 feet) when a depth was reached where either no visual evidence of MGP residuals, or the native clay beneath the fill material was reached. If the confirmation sample analytical results exceeded remediation objectives, the area was excavated an additional foot and re-sampled until the sample results were below remediation objectives, or until a maximum depth of 10 feet bgs was reached. If samples taken from the sidewalls exceeded remediation objectives, the sidewalls were excavated and confirmation samples were re-collected until the property boundary was reached.

Confirmation samples were collected above the water table in riverbank areas A29R, A31R, A33R and A35R. All other samples collected along the riverbank were collected below the water table and were designated as saturated samples.

Composite confirmation samples were collected to compare to the residential property remediation objectives. Grab confirmation samples were collected to compare to the construction worker remediation objective. All confirmation samples were analyzed for PAHs.

2.7.2.5 Property Restoration and Demobilization

The excavation areas were backfilled in lifts to pre-remediation ground surface elevations. Backfill material used at the property included gravel (IDOT CA-1, CM-6 and CA-7) from virgin dolomite quarry sources. Sources of all imported backfill materials were evaluated and samples were collected and analyzed before any materials were transported to the property. Backfill was analyzed for TCL VOCs, TCL SVOCs, PCBs, pesticides, herbicides, TAL metals, and pH and screened against the TACO Tier 1 SLs.

After completion of the remedial action, the riverbank was restored by placing geotextile fabric over the CM-6 surface that was toed into the CM-6 at the base of the slope and at the top of the slope in a trench created in the backfill. Imported RR-4 rip-rap was placed over geotextile fabric in the final step of bank restoration. The surface of the property was graded to establish surface elevations equal to pre-remediation elevations. The property was surveyed to verify restoration to correct surface elevations.

2.7.3 Old Town Village West Parcel

Investigation activities conducted at the Old Town Village West parcel indicated that soils exceeded Illinois EPA Tier 1 soil remediation objectives for residential property use for PAHs, lead and arsenic. A remedial action plan (Pioneer, 2002) was approved by Illinois EPA that included construction of engineered barriers and the development of a Health & Safety Plan to address future construction activities in certain areas of the site. Remedial Action Completion Reports are provided in Appendix K.

Elimination of the soil ingestion exposure route was accomplished by removing surface soil to a depth of 1.5 feet in all landscaped areas of the development to accommodate a 1 foot thick compacted clay barrier and 6 inches of topsoil. In areas of parks, the elevation was raised by 2 feet with compacted clay and topsoil to achieve the engineered barrier requirement. Other areas of the property were covered by concrete walkways or floors/pads of the buildings. As appropriate, structurally unsuitable materials were

excavated from areas of the buildings for construction purposes. Excavated soils totaled about 1,410 in Site Remediation #4 and 975 in Site Remediation #5 which were disposed of as special waste at an Onyx landfill in Zion, Illinois (Pioneer, 2004, 2005). Properties formerly owned by PGL only encompassed portions of these remediation areas (See Appendix K).

Institutional controls implemented for the site include requirements for maintaining the engineered barriers, health and safety plans for any future excavation, handling of future excavated soil in accordance with applicable laws and recording the NFR letter in the chain of title. NFR letters were issued by Illinois EPA for Site Remediations 4 and 5 on January 25, 2005 and June 15, 2005, respectively.

3 CURRENT OU CHARACTERISTICS

3.1 OU Topography and Drainage

The upland portion of the North Station OU is relatively flat and, except for the ComEd substation, the land is unimproved. According to the United States Geological Survey (USGS) 7.5-Minute Chicago Loop Quadrangle, the upland portion of the OU is at an elevation of approximately 590 feet above mean sea level (USGS, 1993). Regional surface water flow is southwesterly toward the ARA, which flows southeast to its confluence with the Chicago Ship and Sanitary Canal approximately five miles downstream from the OU. The ARA is directly adjacent to the LaSalle-Chestnut and Division-Halsted parcels and is separated by a bulkhead wall. Surface water runoff is primarily controlled by multiple storm sewer inlets located on and around the OU that direct most of the surface water into the City of Chicago combined sewer system. Precipitation not collected in storm sewers infiltrates the unpaved ground surfaces.

A survey conducted on the Halsted and Division-Halsted parcels (Sight on Solutions, March 2011) contained a 'Flood Hazard Note' indicating the following:

> *" According to the Federal Emergency Management Agency FIRM Community Panel Number 17031CO419J, with a map revision date of August 19, 2008, part of the surveyed property lies within an area designated as Zone X (unshaded) and part of the surveyed property lies within an area designated as Zone A. Zone X (unshaded) is defined as areas determined to be outside the 0.2% annual chance floodplain and Zone A is defined as special flood hazard areas (SFHAs) subject to inundation by the 1% annual chance flood with no base flood elevations determined, per the Flood Insurance Rate Map (FIRM). These maps do not necessarily show all areas subject to flooding in the community or all planimetric features outside special flood hazard areas. This does not guarantee that the surveyed property will or will not flood."*

The survey, provided in Appendix A5, indicates the limits of SFHA Zones X and A occur within roughly 20 feet of the North Branch Canal water limit.

The National Wetland Inventory online 'Wetlands Mapper' did not indicate the presence of wetlands on the North Station OU nor on adjacent parcels along the ARA. A copy of this map is included in Appendix A6.

3.2 Geology and Hydrogeology – Regional Setting

3.2.1 Regional Geology

The Chicago area geology consists of unconsolidated glacial deposits of Quaternary age sediments consisting primarily of glaciofluvial sand and gravel deposits as well as glaciolacustrine deposits of silt and clay from ancestral Lake Chicago. These deposits overlie Silurian age bedrock deposits. The Chicago area lies within the broad, sloping arch of Paleozoic bedrock called the Kankakee Arch on which bedrock dips gently to the east toward Lake Michigan (Willman,1971).

Surface soils in the OU vicinity consist of Wisconsin episode lake clays and silts associated with Carmi member of the Equality Formation (Lineback, 1979). This unit is described as yellowish brown to brown or bluish-gray to gray clay and silt, well-bedded, soft, commonly thinly laminated and locally varved. Most deposits underlie extensive, flat, low-lying areas formerly occupied by glacial lakes; some are in small, separate lake basins; a few are in slack-water valleys tributary to major river valleys. They are commonly covered by unmapped Richland Loess, thin eolian sand, swamp deposits, or alluvium. Unconsolidated deposits in the vicinity are expected to have a thickness of approximately 50 feet.

The regional bedrock stratigraphy consists of dolomite, limestone, shale, and sandstone and varies between 3,300 and 5,400 feet in thickness (Willman,1971). In general, the top of the bedrock sequence consists of Silurian dolomite of the Niagaran series ranging in thickness from approximately 50 to 500 feet (Willman, 1971). The dolomites and limestones of the Niagaran series contain significant fractures and solution features (B&McD, June 2002).

3.2.2 Regional Hydrology and Hydrogeology

3.2.2.1 Hydrology

Based on the United States Geological Survey 7.5-Minute Quadrangle (1993), the OU is at an elevation of approximately 600 feet above mean sea level. Surface water flow in the area of the OU drains toward the North Branch of the Chicago River.

Natural surface water runoff is primarily controlled by the City storm sewer system. Multiple storm sewer inlets are located around the OU which direct most of the surface water into the City's combined sewer system. However, surface water not captured by the sewer system is primarily directed toward the southwest toward the North Branch of the Chicago River.

The North Branch of the Chicago River was created in the 1870s as a source of clay for the brickyards. The River is one mile long and serves as an alternate route around Goose Island. The River connects around to the North Avenue turning basin and forms the east side of Goose Island. The North Branch of the Chicago River has a straight alignment and consists of vertical steel walls with an average width and depth of 80 to 120 feet and 4 to 8 feet, respectively. According to the Illinois EPA, water quality within the North Branch of the Chicago River is generally fair. Survey stations upstream and downstream of the OU indicate that the greatest impact to water quality is from fecal coliform concentrations due primarily to waste water treatment discharges. The North Branch of the Chicago River supports limited game fish and other aquatic life.

3.2.2.2 Hydrogeology

The shallow groundwater in the Chicago area is limited to sand and gravel horizons in unconsolidated soil and fractured bedrock aquifers (Willman, 1971). Precipitation and surface water infiltration recharge the shallow groundwater aquifers. The OU is in an area designated "E" by the Illinois State Geological Survey (Berg et al., 1984). The "E" region consists of silty to clayey glacial till over 50 feet thick bgs. This till has no interbedded sand and gravel deposits and is relatively impermeable with good attenuation capacity for contaminants (Berg et al, 1984).

Bedrock aquifers are found within Silurian, Ordovician and Cambrian formations, which are greater than 50 feet bgs. The estimated potential yield for the aquifers ranges from 45 million gallons per day (mgd) for the deep Cambrian-Ordovician aquifers to 75 mgd for the unconsolidated glacial drift aquifer (Suter et al, 1959).

3.2.2.3 Potable Wells

A survey was performed to identify the presence of wells located within a 1,000-foot distance of the OU (B&McD, June 2006). Various agencies were contacted with requests for pertinent potable well information, including Illinois State Water Survey; Illinois State Geological Survey; Illinois Department of Public Health (IDPH); Illinois EPA Bureau of Water; Cook County Department of Public Health; City of Chicago Department of Public Health; and City of Chicago Department of Water Management.

Well information was received from the Illinois State Water and Geological Surveys indicated no potable wells are located within a 1,000-foot radius of the OU. Additionally, the City groundwater ordinance prohibits the installation of potable water wells within City limits. A copy of this ordinance is provided in Appendix I. Four private industrial/commercial wells were identified within a one half-mile radius of the

OU extending into the Cambrian-Ordovician bedrock aquifers at depths ranging from 1,240 feet bgs to 2,164 feet bgs (Figure 8).

3.3 Geology and Hydrogeology – Local Setting

3.3.1 OU Geology

The OU has been extensively investigated in multiple phases, as previously noted. Soil boring locations are shown on Figure 26 and boring logs are provided in Appendix B of the Completion Report (NRT, July 15, 2011).

Stratigraphic units identified at the OU included surficial fill and brown/gray clay till. Geologic cross-section locations prepared from boring logs are shown on Figures 9, 13 and 17. The cross-sections are presented in Figures 10, 11 and 12 (ComEd parcel); 14, 15 and 16 (City ROWs); and 18 and (19 LaSalle-Chestnut parcel). These units are described below.

3.3.1.1 Fill Unit

The surficial fill unit at the OU consists of 0 to 12 feet of previously disturbed fill material. The fill is mostly gravel and sand with smaller amounts of silt, clay, bricks, cinders, coal, glass and wood. In numerous instances during probing activities on the former MGP site (ComEd parcel), shallow refusal was encountered which typically correlated to Sanborn map locations of historical MGP building foundations. As expected, the areas in or near the historical MGP structures contain fill material to the total depth of the structure. The fill material encountered inside or near the historical MGP structures consisted primarily of bricks, concrete, rocks, slag, cinders, clinkers and trace coal. A contour map of the fill thickness is shown on Figure 20.

As previously noted, the surficial fill was completely excavated in the remediation of the LaSalle-Chestnut parcel. Clean backfill was replaced in the excavation to the original ground elevations. The fill thickness map (Figure 20) reflects the placement of backfill on that parcel as well.

Analysis of the TOC of fill samples yielded the following results:

Parcel	Boring #	Sample Depth	TOC (mg/kg)
ComEd	SP28-002	12-15	23.16(1)
	SP28-003	22-24	13.51(1)
LaSalle-Chestnut	SB02-001	1-3	170,000(2)

Notes:
(1) Sample was collected from fill within a former oil tank location.
(2) Sample was collected in the fill. Crushed asphalt was observed in the sample

3.3.1.2 Clay Unit

Underlying the fill unit is native brown/gray silty clay till unit. The clay unit consists of a medium to stiff clay with silt and trace amounts of fine gravel. The unit is generally encountered from 1 to 12 feet bgs and has a lithologic thickness of greater than 36 feet. Bedrock was not encountered in any of the borings which extended up to 40 feet bgs. The relative consistency of the unit appears to vary but generally becomes increasingly stiff with depth. In addition, orange and brown mottling may also be sporadically observed in the uppermost portions of the clay suggesting it is seasonally saturated.

Analysis of the TOC of the clay unit yielded the following results:

Parcel	Boring #	Sample Depth	TOC (mg/kg)
ComEd	SP01-001	8-10	13,000
	SP03-001	8-10	10,000
	SB02-001	8-10	8,800
LaSalle-Chestnut	SB01-002	8-10	10,000

3.3.1.3 Bedrock

Regional information suggests the depth to bedrock is approximately 50 feet bgs. Bedrock underlying the OU is Silurian-age Niagara dolomite.

3.3.2 OU Hydrogeology

Groundwater was encountered sporadically during field activities. Recharge of the fill and clay units is dependent on precipitation such that saturated conditions within the fill may be seasonal. The general lack of buildings, asphalt and concrete surfaces combined with the porous characteristics of the fill unit

allow percolation of water which then accumulates over the medium to stiff clay layer directly beneath. Figure 21 illustrates the existing ground cover over the OU and adjacent parcels.

When present, groundwater in the fill appears to be perched. Consequently, depths to groundwater in the fill will depend on the fill thickness and/or depths to the clay till. A contour map of the elevation of the top of the clay unit is shown on Figure 22. Where highly permeable material (e.g. crushed rock) has been used as remediation backfill, enhanced percolation can result in locally elevated groundwater levels, as has been observed on the ComEd property in Well SMW02 located in close proximity to the 1999 remediated area (Barr, April 9, 2001). Similar backfill material used in the remediation at the LaSalle-Chestnut property will likely have similar effects in enhancing recharge.

The North Branch of the Chicago River is also a source of recharge to the fill and clay till units during times of elevated river stages. During elevated river stages, groundwater flow directions may temporarily reverse.

Four monitoring wells were installed on each of the ComEd (B&McD June 2002) and LaSalle-Chestnut (B&McD June 2006) properties in separate investigations. Wells terminated in both the fill and within the clay till. Groundwater at the OU was observed at depths ranging from about 3 to 15 feet bgs.

The clay unit is likely saturated but does not meet the Illinois EPA definition of a Class I aquifer, as defined in 35 IAC, Subtitle F, Chapter 1, Part 620 – Groundwater Quality, Section 210. The City has an ordinance banning the use of groundwater for potable purposes and there are no potable water sources derived from groundwater within one mile of the OU. A copy of the ordinance is presented in Appendix I. The City of Chicago obtains its municipal water supplies from Lake Michigan.

3.3.2.1 Groundwater Flow

Based on water elevations collected from the monitoring wells on both the ComEd and LaSalle-Chestnut parcels, subsurface groundwater flow were reasonably consistent, trending on a west to southwest orientation (Figures 23 and 24). At the time of the measurements, groundwater flow was toward the North Branch of the Chicago River which is the likely discharge area for shallow groundwater. During periods of elevated river stages, it is probable that groundwater flow directions will reverse temporarily and the North Branch of the Chicago River will recharge the shallow groundwater.

3.3.2.2 Gradients

The horizontal hydraulic gradient for the two available groundwater contour maps were relatively consistent. Gradients were moderate and ranged from 0.013 to 0.055. There were no well nests installed to evaluate vertical gradients.

3.3.2.3 Hydraulic Conductivity

A Shelby tube sample was collected on the ComEd parcel from soil boring SB02 at 12 to 14 feet bgs. The hydraulic conductivity for this clay unit sample was 1.0×10^{-7} centimeters per second (cm/s). The sample grain size distribution was 0% gravel, 13.4% sand and 86.6% fines (30.7% clay).

A Shelby tube was also collected on the LaSalle-Chestnut parcel from soil boring SB04 at 6 to 8 feet bgs. The hydraulic conductivity for this sample was 2.6×10^{-8} cm/sec. The sample grain size distribution was 0% gravel, 12.9% sand and 87.1% fines (36.9% clay).

The Shelby tube samples assess hydraulic conductivity in a vertical orientation. Horizontal hydraulic conductivity would be expected to be higher if measured in monitoring wells by in-situ methods.

3.3.2.4 Infrastructure and Preferential Migration Pathways

The main migration pathway to the subsurface is through the fill material, which typically lies from the surface to 12 feet bgs. The highly permeable fill material consists of gravel and sand with smaller amounts of silt, clay, brick, cinders, glass and wood. Migration of dense non-aqueous phase liquid (DNAPL) and affected groundwater also occurs through fractures in the clay.

Subsurface utilities on and surrounding the OU create potential preferential pathways for migration. Existing utility infrastructure are shown on Figure 25. Electric, water, sewer, gas and phone lines are present under the streets surrounding the OU. Electric lines are also known to radiate from the ComEd parcel, and one 15-inch sewer line crosses the parcel from east to west.

Water and sewer line runs east-west along Hobbie Street at the southern end of the ComEd parcel, just outside the fence and the areas where MGP residuals occur. The water line is 12 inches in diameter, and the sewer line is 13-feet by 13-feet, and both are likely surrounded by more permeable backfill. The area where MGP residuals occur is believed to have extended outside the ComEd property line; therefore, both are potential pathways for MGP residual migration.

A water main, sewer line, and electric lines run north-south along the eastern ComEd parcel boundary under North Crosby Street. MGP residuals may extend below North Crosby Street; therefore, the utility lines are potential pathways.

A 4-foot by 5-foot sewer line. Along with a water line and phone line, runs north-south under Kingsbury Street and several subsurface electrical distribution lines spider from the substation offsite. MGP residuals occur along the western property line extend toward Kingsbury Street; therefore, the utility lines are potential pathways.

The existing data do not allow evaluation of the potential impact of these shallow underground utility lines to intercept groundwater affected by MGP residuals from the Site. The depths of these utilities have not been described to assess whether they intercept the water table and act as potential preferential migration pathways. If these utility trenches are installed near or below the fill/clay unit interface, there is potential for these structures to serve as conduits for preferential migration.

A ComEd tunnel, MWRD deep tunnel structure and City outfall sewer also occur in the central and southern portions of the LaSalle-Chestnut parcel (Figure 26). Borings performed during the remediation of this parcel (SP14 through SP19) indicate that preferential migration of MGP residuals is not occurring along the MWRD deep tunnel structure and City outfall sewer on the southern portion of this parcel. Several borings (SB-1, SB-3, BH-6) were performed along the ComEd tunnel by LFR (July 2002) to depths up to 37 feet bgs which also demonstrated that no preferential migration of MGP residuals is occurring along this tunnel structure.

3.4 Meteorology

Weather in the area of the OU is continental in nature with cold dry winters and warm humid summers. Short duration, relatively large magnitude changes in temperature, humidity, precipitation, and wind direction are common.

Average monthly temperatures range from about 22 degrees Fahrenheit (ºF) in January to about 73 ºF in July. The high and low monthly averages range by approximately ±10 ºF from the monthly mean. Almost 60% of the total annual rainfall generally occurs between May and October. Almost 90% of the total annual snowfall occurs between December and March. Overall, the average annual temperature for the area is 49 ºF and over 74 total inches of precipitation (i.e., both rain and snow) is received.

Annual mean weather conditions at O'Hare International Airport, calculated for the period between 1971 and 2000, are presented in the table below (Midwest Regional Climate Center 2008).

Monthly Weather Conditions at O'Hare International Airport

Month	Monthly Temperature Ranges (°F)			Monthly Averages (in.)	
	High	Low	Mean	Precipitation	Snowfall
January	29.6	14.3	22	1.8	11.3
February	34.7	19.2	27	1.6	8.3
March	46.1	28.5	37.3	2.7	6.0
April	58	37.6	47.8	3.7	1.6
May	69.9	47.5	58.7	3.4	0.0
June	79.2	57.2	68.2	3.6	0.0
July	83.5	63.2	73.3	3.5	0.0
August	81.2	62.2	71.7	4.6	0.0
September	73.9	53.7	63.8	3.3	0.0
October	62.1	42.1	52.1	2.7	0.3
November	47.1	31.6	39.3	3.0	1.8
December	34.4	20.4	27.4	2.4	8.7
Annual Precipitation Totals				36.3	38

Wind in the area of the OU is from the south, southwest, or west direction approximately 47.1 percent of the time. The most common wind direction is south, which occurs 11.9 percent of the time. Mean wind speed in the prominent wind direction (south) is 10.6 miles per hour.

3.5 Population and Land Use

The population of the City of Chicago is approximately 2,890,000 people, based on the 2000 U.S. census. The North Station OU is zoned by the City for manufacturing land use. At present, the area surrounding the OU includes new residential property developments to the northeast, southeast and south. The adjacent Halsted parcel to the west is zoned manufacturing and is part of the construction equipment storage yard. Planned development and planned manufacturing is located further to the west across the North Branch of the Chicago River. Figure 4 presents the OU and surrounding area zoning as obtained from the City of Chicago Planning and Zoning Bureau website on June 12, 2011.

The owner of the LaSalle-Chestnut property reported that the future land use is expected to be residential condominiums. A considerable amount of residential redevelopment is also occurring in the surrounding area and zoning is expected to change to reflect this trend (B&McD, June 2006). The southern portion of this property also has an approximately 42" diameter drop shaft that accesses the Metropolitan Water Reclamation District of Greater Chicago (MWRD) deep tunnel.

3.6 Cultural and Natural Resource Features

An ecological compliance assessment tool (EcoCAT) search dated June 28, 2011 of the Natural Heritage Database maintained by the Illinois Department of Natural Resources lists no state threatened and endangered species or pristine natural areas near the OU; although, the Peregrine Falcon is listed as a protected resource in the area. The Historic Architectural/Archaeological Resources (HAARGIS) database did not identify any historic or archaeological sites on the OU (search date June 28, 2011). A National Wetland Inventory maps database search dated June 28, 2011 does not identify any wetland areas other than the North Branch of the Chicago River, proper (riverine). A copy of the EcoCAT natural resource review results is included in Appendix A6.

3.7 Previous Investigation Findings and Current OU Status

The discussion below summarizes the quality and conditions of OU media based on the remedial investigations and remedial actions that have been performed to date. Boring log observations and analytical results within the depth intervals where soil has been excavated and removed from the LaSalle-Chestnut parcel were not considered in the following discussion.

3.7.1 Soil Quality and Potential Tar Sources

Figure 26 shows the relative degree and extent of MGP residuals across the study area, based solely on visual, olfactory and PID notations on the boring logs. Borings are color-coded to indicate areas where 1) no MGP residuals were observed, 2) visual evidence of discolored/stained soils was observed, 3) observation of oily sheens and/or light non-aqueous phase liquid (LNAPL) were made and 4) observation of coal tar saturated soils and/or DNAPL were made. Numerous borings encountered shallow obstructions such that penetration was insufficient to yield useful subsurface information. These borings, and others that were blind drilled, are shown but are not color-coded.

Because Figure 26 is based solely on boring log notations, locations where no MGP residuals were observed does not also mean that all soil analytical results were below residential screening values. Similarly, the observation of discolored/stained soil alone does not imply the presence of MGP-related residuals. Locations where sheens, LNAPL, and DNAPL were noted are intended to illustrate the distribution of more highly affected areas of the OU and adjacent properties.

3.7.1.1 Areas Upgradient of Former MGP Operations

Crosby Street adjoins the ComEd parcel on the east property boundary and is upgradient of the former MGP operations. Thirty-three borings, including one monitoring well were performed along the Crosby Street ROW. A number of borings adjacent to the OU on the west side of the street reported 'slight discoloration' (Figure 26). No tar-stained soils or sheens were observed in any of the borings along the ROW except B22, B23 and SP65 located adjacent to the eastern 500,000 Relief Holder/Oil Tank on the southeast corner of the ComEd parcel. These areas of stained soil, sheens and coal tar in clay fractures also extended around the relief holder to the south along Hobbie Street.

Additional subsurface investigation was also performed further to the east on the former Spanjer Property, including the Old Town Village West parcel. A monitoring well (MW4/NS006) was installed at the intersection of Crosby and Elm St (Barr, 2001). This upgradient monitoring well (MW4) noted LNAPL (described as "black sand and gravel with heavy free-phase product") at the water table (about 6 feet) directly over the clay unit. Four USTs (#1, #2, #3 and #4), not related to the MGP operations, were formerly located immediately upgradient of MW4 (Appendix K). A groundwater sample from the well detected only a few PAHs at very low concentration and did not detect any VOCs. No visible or olfactory evidence was noted in soil boring SP82, located 30 feet north of MW4. Notations of visible and olfactory observations on other historical borings surrounding these USTs (Appendix K: B24, B25, B46, B56, B57) performed following their removal (Pioneer, 2002) did not include NAPL above the clay. Theses notations suggest that the observation of free-phase product in MW4 was localized. Benzene and PAHs were also detected in fill samples adjacent to the USTs collected by K-Plus Environmental (2001).

Stained soil and/or petroleum odors were also noted in historical boring logs surrounding USTs #5 and #6 located directly east of the above-mentioned observations around MW4 and along Elm Street (Appendix K: B34, B45, B50, B51). These USTs are north of the Old Town Village West parcel and were not associated with the MGP operations.

One historical boring performed directly east of USTs #8 and #11 along Howe Street (Appendix K: B32) showed no visual/olfactory evidence of a release. The UST removal report (Pioneer, 1999) for UST 11 also reported very low PID responses in samples collected from the excavation base and sidewalls ranging from 1.6 to 5.6. No soil PID screening results were not available for the other USTs.

Two borings were performed adjacent to the location of the former building which housed a tar vat identified on the Old Town Village West parcel during the period that it was owned by PGL (see Appendix K, Attachment K-1). The two borings were labeled B-18 and KB-18. Boring B-18 showed no visual/olfactory evidence of impact. A sample collected from a depth of 5 - 7.5 feet bgs exhibited no VOCs. Several PAHs were detected in the sample, including pyrene (380 micrograms per kilogram [ug/kg]), benzo(a)pyrene (180 ug/kg), chrysene (330 ug/kg), dibenzo(a,h)anthracene (380 ug/kg), benzo(g,h,i)perylene (420 ug/kg) and phenanthrene (330 ug/kg). The log for boring KB-18 is not available.

There was no visual or olfactory indication of a release at USTs #7 and #9 located along Crosby Street, based on historical borings B27 and B47 (Appendix K). These USTs are on the Old Town Village West parcel but were not associated with the MGP operations.

3.7.1.2 Former MGP Operation Areas

The following sections refer to historic MGP structures shown and labeled on Figure 3, along with historic soil borings shown on Figure 26.

ComEd Parcel

During the site investigation activities, visual staining of soil, sheens, LNAPL and coal tar were observed to varying degrees throughout the parcel, with the exception of the area on the far north end. Borings SP01, 02, 03 and 05, located north of the Electrical Control Building, as well as borings along the Division Street ROW showed no visible, olfactory or PID evidence of MGP residuals down to 20 feet bgs. Areas where affected soil and/or groundwater were identified are discussed below, proceeding from the north end of the ComEd parcel toward the south.

Upgradient Parcel Boundary

Four borings were performed on the ComEd parcel near the property boundary along Crosby Street between the former 1.5 million gas holder to the north and the 500,000 Relief Holder/Oil Tank to the south (SP26, SP25, NS9907 and SP30). [Note: SP 24, SP 31and SP32 hit auger refusal within 5 feet

bgs and are not discussed.] Each of these borings noted slight tar staining and/or LNAPL from the water table down to about 12 feet bgs. The water table appeared to coincide with the top of the clay unit. Below 12 feet, there were no visual, olfactory or PID evidence of MGP residuals down to 20 feet bgs.

750,000 Gallon Oil Tank

Investigation could not be performed inside the 750,000 gallon oil tank due to its location below the electrical control building and bus system. Two borings performed generally downgradient of this oil tank showed oil stained soil from 6 feet to 20 feet in SP04 and at 5 feet bgs in SP27, along with elevated PID readings up to 176 ppm.

As previously noted, ComEd performed limited remedial activities in an area roughly 30 feet by 60 feet, a portion of which included the southeast corner of this oil tank. No details concerning this activity were available.

Buried Oil Tank

This oil tank is located immediately west of the 750,000 gallon oil tank. All four borings performed within the tank area (NS9904, NS9909, NS9910 and SP28) encountered tar stained soils and sheens at the water table (about 5 feet bgs). Coal tar DNAPL extended to about 24 feet bgs. Comments on boring logs suggest the tank may have been encountered between 11 and 17 feet bgs. Boring SP06, west of this tank and adjacent to the Tar Tank, also showed stained soil from 8 to 21 feet bgs.

Tar Tank/Buried Oil Tanks (3)

This area, located in the northwest corner of the ComEd parcel, was the subject of an interim remedial action conducted by Barr (April 2001). Soils were excavated in a 36 feet by 67 feet area to a depth of approximately 4.5 feet. One crushed galvanized steel tank (20 feet long by 8 feet in diameter) was also removed and is presumed to be one of these oil tanks. The excavation interval of 3 feet bgs to the total excavated depth of 4.5 feet showed visible signs of oily coal tar (free phase) and coal tar residuals. These MGP residuals appeared to be mainly associated with perched water present at the top of clayey fill. A new set of capacitor banks has since been installed over the excavated area.

Stained soils and/or coal tar sheen were observed below the excavated depth from the water table (4 to 5 feet bgs) to about 11 feet bgs (NS9901, -2, -3, -5 and SB01). LNAPL was also observed downgradient to the south at the water table in NS9905.

Affected soil and groundwater extend off the ComEd parcel under Kingsbury as indicated by sheen, tar-stained soil and/or coal tar in the clay unit fractures in numerous borings between the remediated area and Oil Pump House #1 (Figure 26).

Gas Holder - 1.5 Million Cubic Foot

One boring (NS9908) was performed on the east edge of the footprint of the former 1.5 million gas holder. The boring encountered sandy lean clay fill materials to 6 feet bgs where the fill materials became more gravelly and contained a much higher proportion of concrete, wood and metal debris. Fill materials from the water table at 5 feet bgs to the total depth of the boring at 14 feet bgs showed black staining with moderate to strong coal tar odors and moderate to heavy sheen. Monitoring well MW-1 was installed at this location with a screen depth of 4 to 14 feet bgs. Waters removed from the well were saturated with a heavy coal tar free-phase product.

Naphtha Tank/Buried Oil Tank

No investigation could be conducted at this location due to the proximity of substation infrastructure.

Revivifying House/Purifying House

Three borings performed in this vicinity which are also downgradient of the former 1.5 million gas holder. An oil sheen and light coal tar staining were noted from 4 to 8 feet bgs in SP36 and SP08, respectively. SP07 exhibited no olfactory or PID evidence of MGP residuals.

Oil Tanks/ Oil Condenser/Tar Settling Tanks/Tar Extractors/ Oil Scrubbers

No investigation could be conducted at these locations due to the proximity of substation infrastructure. Borings performed downgradient of these former MGP features exhibit oil and/or tar-stained soil at or just below the water table (4 to 8 feet bgs) and coal tar in clay unit fractures extending to 12 to 22 feet bgs. These locations include SP12, SP13, SP14, SP35, SP55C, SP16, SP56 and SB-06 in the southeast quarter of the ComEd parcel.

As previously noted, ComEd performed limited remedial activities in an area roughly 30 feet by 60 feet immediately southeast of the larger tar settling tank (Figures 3 and 6). No details concerning this activity were available.

500,000 Relief Holders/Oil Tanks

Within the western 500,000 Relief Holder/Oil Tank, fill consisted of sand, gravel and clay soil along with brick fragments and cinders. Drilling resistance was encountered at 21 feet bgs inside this relief holder,

suggesting a possible depth of the structure floor. This fill typically exhibited little olfactory evidence of MGP residuals in the upper 18 to 20 feet. Below 20 feet, the soil is coated with tar. Boring SP-49, located immediately south of this structure exhibited tar with clay unit fractures from 12 feet to 20 feet bgs. These conditions extend under Kingsbury St. to the southwest where coal tar was observed in clay unit fractures at SP62, SP74, SP75 and SP85.

The presence of tar and tar-stained soil and fill (brick fragments, clinkers and wood) was more prevalent in the eastern 500,000 Relief Holder/Oil Tank. Tar-stained soils were typically observed near the water table (about 4 feet bgs). Tar was frequently encountered below 4 to 8 feet, extending into clay unit fractures to as deep as 26 feet. The tar extends outside the eastern 500,000 Relief Holder/Oil Tank in adjacent borings SP-21, SP23, SP29 and SB07 as well as SP64 along Hobbie St. The floor of the east holder was noted in drilling logs as occurring at roughly 20 feet bgs.

Kingsbury Street

Kingsbury St. is immediately downgradient of the former MGP operations on the ComEd parcel and is included within the boundaries of the OU. As discussed in Section 1.5.2.3, a subsurface containment wall was installed to prevent MGP residuals from migrating onto the LaSalle-Chestnut parcel. The containment wall location is shown on Figure 7.

Borings performed along Kingsbury exhibited varying levels of MGP residuals, ranging from tar-stained soil and sheens to visible coal tar in fractures within the clay unit. Olfactory observations of MGP residuals indicated the most visibly affected areas were downgradient of the Tar Tank/Buried Oil Tanks (3) to the north and downgradient of the tar settling tanks and western 500,000 Relief Holder/Oil Tank to the south (Figure 26). Between these areas, there appears to be a continuous sheen at the water table along Kingsbury.

Five test pits (TP-1 to TP-5) were excavated along the east side of North Kingsbury Street to determine the location and condition of former MGP discharge lines (Figure 26). The depth of excavation ranged from approximately 6 to 10 feet bgs. The former MGP discharge lines were encountered in three of the test pits (TP3, TP4, and TP5) and were broken at each location encountered to evaluate the contents of the pipes. One 6-inch diameter, stainless-steel pipe was determined to be empty, and the other two pipes, which were 24-inch diameter, iron pipes, were filled with water. A slight sheen was observed on the water upon initially breaking the pipe; however, after letting the pipes drain, the oily sheen was not evident on water remaining in the pipes. No coal tar residuals or free product were observed in any of the pipes.

LaSalle-Chestnut Parcel

The LaSalle-Chestnut parcel is located downgradient of the former MGP operations between Kingsbury St. and the ARA. Visual and olfactory observations during the soil borings on this parcel suggested minimal presence of MGP residuals, other than coal, cinders, bricks and wood debris in the fill. An oily sheen was observed at the base of the fill unit at NS001 along Kingsbury St. and NS005 above a deep tunnel structure. Adjacent borings indicate these sheens were localized occurrences. The soil in these areas was excavated to depths encompassing the sheens during the site remediation.

Staining and a slight odor were observed along the northeastern property boundary in SP10. Tar staining, an oil sheen and relatively low PID reading of 11.7 ppm were observed within fractures in the brown/gray silty clay layer from 8 to 10 feet bgs. This area was also excavated to a depth of 10 feet during the remediation.

Additional soil samples were collected during remedial activities to further define subsurface conditions in the area of the MWRD deep tunnel structure and City of Chicago outfall sewer located on the south portion of this parcel (Figure 26). Boring logs indicated no visual or olfactory evidence that these structures are acting as preferential migration pathways for MGP residuals.

As noted previously, post-remediation confirmation soil samples were collected from each excavation area floor and, if applicable, sidewalls to demonstrate that the remediation objectives had been achieved. The confirmation samples indicated the following:

- Illinois EPA residential soil ingestion remediation objectives were met for all soil remaining on the property; and
- Illinois EPA construction worker remediation objectives were met for all soil remaining on the property with the exception of soil deeper than 10 feet below the original ground surface in excavation area A16. Area A16 coincides with the location of soil probe SP10 where tar staining and oil sheen were observed at 8 to 10 feet bgs.

Division-Halsted Parcel

The Division-Halsted parcel is located downgradient of the former MGP operations between Kingsbury St. and the ARA. Visual and olfactory observations during soil borings on this parcel identified coal tar saturated or stained soil in the fill along Kingsbury St. (SB03, SB05, SB09, SP-5 and SP-17). These stained soils appeared to be limited to an approximately one foot thickness at a depth that coincided with encountering the water table. Stained soil, LNAPL and/or oily sheens were observed upgradient of these locations on Kingsbury St. and on the ComEd parcel.

A solvent odor and PID of 71 was noted near the ARA at SB01. This location is shaded green on Figure 26 because there was no soil staining and these observations do not appear to be related to the MGP residuals along Kingsbury.

Borings performed along the southern boundary of this parcel (B-1, B-6 and SB04) extended to 16 to 18 feet and showed no visual or olfactory evidence of MGP residuals. These findings suggest the MGP residuals remaining in excavation area A16 on the LaSalle-Chestnut parcel are localized in extent.

3.7.1.3 Areas Downgradient of Former MGP Operations

Halsted Parcel

The northwest portions of the Division-Halsted parcel, where coal had not been stored for MGP operations, are referred herein as the Halsted parcel and are off the OU. This parcel is located downgradient of the former MGP operations between Kingsbury St. and the ARA. The 1910 Sanborn map (Appendix A1) indicated the parcel was occupied by the Philadelphia Coal and Iron Co. and Chicago Wood and Coal Co., both of which stored coal on the property. A service station with gasoline USTs also operated on the north end of this parcel during at least 1935 through 1950 (Figure 3). Visual, olfactory and PID observations made in Geoprobe borings identified black-stained soil at the interface of the fill and clay units (5 feet to 8 feet bgs) along Kingsbury St. (SP-12, SP-14, SP-15, SP-16) and on the northern portion on this parcel (SP-1, SP-11). These conditions were limited to about a one to two foot interval. Coal tar, stained soil, LNAPL and oily sheens were observed upgradient of these locations on Kingsbury St. and on the ComEd parcel. Black-stained soil was also observed in the south central portion of this parcel at 5 to 7 feet bgs that boring logs indicate was associated with the presence of coal.

3.7.2 Surface Soil Investigation Results

Surface soil analytical results discussed herein refer to samples collected within the upper 3 feet bgs. Forty-one samples were collected on the OU, in City ROWs and on the Halsted property during various investigations. Surface soil analytical results for samples collected on the OU are tabulated in Appendix H. Results for samples collected on the Halsted property and in the City ROWs are provided in Appendices D2 and D3, respectively of the Completion Report (NRT, July 15, 2011).

3.7.2.1 ComEd Parcel

Sixteen soil samples were collected from depths between one and four feet bgs from widely spaced locations on the ComEd parcel. Samples were analyzed for VOCs, SVOCs metals and cyanide.

Only two samples exceeded residential soil SLs for VOCs (benzene and ethylbenzene). One of these samples (SP33) also showed an exceedance for 3,3-dichlorobenzidine which is not related to MGP operations. These samples were located in areas with coal tar at the eastern 500,000 Relief Holder/Oil Tank. The general absence of VOCs in shallow soils reflects the high permeability of the fill material and lack of a soil cover (e.g. concrete) to impede volatilization.

PAH concentrations exceeded residential soil SLs in every sample. Compounds commonly exceeding SLs were those with relatively low residential screening values, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Naphthalene only exceeded the standard in five surface soil samples; within the tar tank and oil tank on the far north end of the ComEd parcel as well as within the east and west 500,000 Relief Holders/Oil Tanks on the south end.

Arsenic exceeded the residential soil SL of 390 ug/kg in virtually every sample at concentrations ranging from 2,500 ug/kg to 44,500 ug/kg. Other metals as well as total cyanide remained below residential soil screening values.

3.7.2.2 City Right-of-Ways

Four surface soil samples were collected east of the OU in the parkway along the east side of Crosby Street. The sample locations included SP80, SP82, SP83 and SP84 at depths of 2 to 3 feet bgs (B&McD, May 2003). Five surface soil samples were also collected along the southwest side of the ComEd parcel on Kingsbury Street and three samples along the south side of the ComEd parcel on Hobbie Street (LFR, July 2002). The sample locations were in areas adjacent to the west and south sides of the 500,000 Relief Holders/Oil Tanks at depths of 1 to 3 feet bgs. Surface soil sample analytical results for VOCs, BTEX, PAHs and/or metals on this parcel are tabulated in Appendix H.

No residential soil SLs were exceeded for VOCs. All VOC and BTEX results were below detection limits except for 25 ug/kg of 1,1,1-trichloroethane detected in SP83.

PAH concentrations exceeded residential soil SLs at all sample locations for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene, compounds with relatively low residential screening values.

Arsenic was the only metal analyzed that exceeded its residential soil SL of 13,000 ug/kg. Concentrations ranged from 7,800 ug/kg to 16,000 ug/kg.

3.7.2.3 LaSalle-Chestnut Parcel

Surface soils were excavated on the LaSalle-Chestnut parcel during the remediation conducted in 2006-2007. Backfill soils imported to this parcel were analyzed for TCL VOCs, TCL SVOCs, PCBs, pesticides, herbicides, target analyte list (TAL) metals, and pH. Surface soils on this parcel do not warrant further evaluation and are not discussed herein.

3.7.2.4 Division-Halsted Parcel

Twelve soil samples were collected from depths between the ground surface and three feet bgs from widely spaced locations on the Division-Halsted parcel. Samples were analyzed for TCL VOCs, TCL SVOCs, metals and cyanide. Sample locations SB01 through SB12 are shown on Figure 26. Analytical results are presented in Appendix H.

Concentrations of all VOCs in these samples were below detection limits. PAH concentrations exceeded residential soil SLs in all eight samples for compounds with relatively low residential screening values, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Several samples also exceeded screening values for benzo(k)fluoranthene, chrysene and naphthalene. The presence of naphthalene above the soil screening values tends to be located closer to Kingsbury Street and show little relationship to the location of former coal storage on this parcel.

Arsenic concentrations ranged from 4,100 ug/kg to 16,000 ug/kg, some of which exceeded its residential soil SL. An anomalously high lead concentration of 5,000 mg/kg was observed in SB06 on the western side of this parcel.

3.7.2.5 Halsted Parcel

One soil sample (SP-11) was collected from depths between the one and three feet bgs on the Halsted parcel and analyzed for VOCs, SVOCs, PCBs, pesticides, TAL metals and cyanide. The sample location is shown on Figure 26. Analytical data are provided in Appendix H.

All VOCs were below detection limits. PAH concentrations exceeded residential soil SLs for compounds with relatively low residential screening values, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. No pesticides or PCBs were detected.

No metals analyzed exceeded their residential soil SLs.

3.7.3 Subsurface Soil Investigation Results

Subsurface soil analytical results discussed below include samples collected at depths greater than 3 feet bgs. Analytical results for samples are provided in Appendix H.

3.7.3.1 Organic Parameters

Organic compounds, specifically BTEX and PAHs, are the primary indicators of MGP residuals in the subsurface soils. Their occurrence on the OU and within the study area is reasonably well defined by the existing data and reflects the visual and olfactory observations in boring logs. VOC, BTEX and PAH analytical data for subsurface soil are provided in Appendix H.

VOCs/BTEX

Locations within the study area where the soil sampling results exceeded residential soil SLs for benzene are shown on Figure 27. Whereas VOCs and/or BTEX were rarely detected in surface soils (0 to 3 feet bgs), benzene and ethylbenzene concentrations in subsurface soils were detected in significant concentrations at depth. Where benzene and ethylbenzene are detected, they often exceed the residential soil SL (1,100 ug/kg and 5,400 ug/kg, respectively) and occur with toluene and xylene. Benzene concentrations are most significant (exceeding 100,000 ug/kg) in the area of the former tar settling tanks and 500,000 Relief Holders/Oil Tanks on the south end of the MGP operations. These elevated BTEX levels coincide with observations of tar in clay fractures at depths ranging from about 10 to 30 feet bgs. Six borings in this area of the property also show elevated styrene concentrations ranging from 3,000 ug/kg to 31,000 ug/kg, suggesting aerobic degradation of ethylbenzene is occurring.

Soil boring log observations also indicate significant benzene concentrations on the north side of the former MGP operations near tar and oil tanks and the 1.5M Gas Holder. Benzene concentrations in subsurface soils ranged from 7,100 ug/kg to 29,000 ug/kg in these areas. Downgradient concentrations of benzene in subsurface soils along Kingsbury Street of 1,000 ug/kg to 10,000 ug/kg were typical. The area of residential soil SL exceedances for benzene extended slightly west of Kingsbury onto the adjacent Halsted parcel at SP-14 and SP-16.

Frequent detections of acetone and methyl ethyl ketone along with single, isolated detections of 1,1,2,2-tetrachloroethane, 4-chloroaniline and bromomethane are assumed to be laboratory and/or sampling artifacts.

PAHs/SVOCs

Areas where the soil samples exceeded the naphthalene residential soil SL (3,600 ug/kg) are shown on Figure 28. On the ComEd parcel, naphthalene exceedances occurred at locations where benzene SLs were also exceeded. Additional samples exceeded naphthalene SLs in the northeast portion of the ComEd parcel, near the former oil and tar tanks. At locations where naphthalene is detected, residential soil SLs are exceeded for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and/or indeno(1,2,3-cd)pyrene. The SVOC 2-methylnaphthalene was commonly detected, but only exceeded its residential soil SL (310,000 ug/kg) in locations with high BTEX and PAHs. A number of borings include samples at multiple depths, up to 40 feet bgs, to establish the vertical extent of PAHs in the soil.

Only five boring locations on the ComEd parcel did not exceed any residential soil SL and four of these borings were located upgradient along the north and east property lines (SP-01, SP-05, SP-30 and SP-68).

Similar to benzene, naphthalene exceedances of residential soil SLs extend west of Kingsbury Street only onto select locations along the eastern edges of the Division-Halsted and Halsted parcels. Each boring location on the Division-Halsted and Halsted parcels exceeded SLs for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and/or indeno(1,2,3-cd)pyrene. Given the historical use of these properties for coal storage, PAHs are inevitably widespread within the fill. However, deeper soil samples collected within the clay unit on these parcels were typically below detection limits.

As previously discussed, extensive excavation was conducted on the LaSalle-Chestnut property to achieve Illinois EPA residential and construction worker remedial objectives. Comparison of the

confirmation sample results to the residential soil SLs in the multi-site risk assessment framework indicate roughly one-third of the excavation floor areas exceed screening values for various PAHs, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene and/or indeno(1,2,3-cd)pyrene as well as naphthalene at two locations. Excavation areas where confirmation sampling exceeded residential PAH SLs are shown on Figure 7.

PAHs in samples representing material that was not excavated from the LaSalle-Chestnut or ComEd parcels, as well as samples on the remaining parcels, are screened against industrial SLs on Figure 31. PAH exceedences of the industrial SL are present throughout the study area.

3.7.3.2 Cyanide

Cyanide analytical results are provided in Appendix H. Concentrations of total cyanide in subsurface soils were below the residential soil SL (1,600 mg/kg) on the OU and within the study area. Wood chips were observed within the fill in numerous borings on the ComEd and LaSalle-Chestnut parcels but the fate of the oxide box wastes is unknown. Boring logs suggest that dispersal of some of the material occurred on the OU but it is not present as an identifiable point source.

3.7.3.3 Metals

Metals analytical results are provided in Appendix H and Figure 30. Arsenic concentrations exceeded the background concentration for metropolitan counties of Illinois (13,000 ug/kg) at locations scattered about the study area. A greater percentage of samples collected in the northern part of the ComEd parcel, the Halsted parcel, and the Division-Halsted parcel exceed the SL than those samples collected in other portions of the study area.

Exceedances of the residential soil SL for lead (400 mg/kg) were limited to isolated occurrences at single sampling locations on the ComEd (SP44) and Division-Halsted (SB01) parcels (Figure 29). Six boring locations on the Halsted parcel exceeded residential soil SLs and, at several locations near the ARA, concentrations exceeded 1,000 mg/kg. Several of these high lead sample locations also exceeded the residential soil SL for antimony (31 mg/kg) at concentrations ranging from 41 to 180 mg/kg. The distribution and magnitude of these lead and antimony concentrations in soil do not appear related to former MGP operations, but rather to previous activity on the Halsted parcel.

3.7.4 Groundwater Quality Results

Groundwater samples were collected for analysis on the North Station OU at 13 well locations and on the adjacent Halsted parcel at 5 locations from 2001 through 2011. Samples were analyzed for VOCs, BTEX, PAHs, SVOCs, metals, cyanide and/or general groundwater parameters. Groundwater results were grab samples from temporary wells representing one-time sampling events. Therefore, a discussion of quality changes and trends over time is not possible. The groundwater sample locations were as follows:

Well Location	**Well ID**
Crosby Avenue	MW-4
ComEd Parcel	SMW02, SMW03, SMW04, SMW05, PZ01, PZ02
LaSalle-Chestnut Parcel	SMW01, SMW02, SMW03, SMW04,
Division-Halsted Parcel	PZ01, SP-5
Halsted Parcel	B-2, SP-2, SP-11, SP-12, SP-14

Analytical data are provided in Appendix H. Figures 27, 28, 29 and 30 show the observed concentrations of benzene, naphthalene, lead/cyanide and arsenic, respectively, in groundwater. These results are discussed below.

3.7.4.1 Organic Parameters

Upgradient groundwater quality is represented by water table wells MW4 (Crosby Street) and SMW03 (ComEd parcel) (Figure 27). SMW03, located on the far northeast corner of the ComEd parcel exhibited no VOCs, SVOCs or PAHs above detection limits. MW4 was located across Crosby Street, east of the OU and in a City sidewalk ROW. Moderate to strong odor and sheen was noted at the water table (6 feet bgs) and at the top of the clay (7 feet bgs) during the soil boring for this well. Despite these observations, there were no VOCs present above detection limits. Few PAHs were detected at relatively low concentrations but above the residential groundwater SLs. These parameters included benzo(a)pyrene, benzo(b)fluoranthene and benzo(k)fluoranthene (Appendix H).

Two wells (Appendix K: MW4 and MW5) were installed along and east of Crosby Street on the Old Town Village West parcel by Pioneer (2002). Well MW4 was installed in close proximity to MW4 installed by Barr (2001). The soils observed during installation exhibited gasoline odor at the water table but groundwater sampling detected no VOCs or RCRA metals (Appendix K). Similar to MW4 installed by

Barr, the well also detected the same PAHs at relatively low concentrations but above the residential groundwater SLs. MW5, located along Crosby Street further south, detected no VOCs, RCRA metals or PAHs. As previously discussed, a voluntary remediation has been completed and Illinois EPA issued NFR letters on this property.

Monitoring wells within or immediately adjacent to areas exhibiting MGP residuals on the ComEd parcel included MW1, SMW02, SMW04 and SMW05. Well MW1 was located within the 1.5M Gas Holder near the north end of the parcel. During the soil boring for MW1, fill materials from the water table at 5 feet bgs to the total depth of the boring at 14 feet bgs showed black staining with moderate to strong coal tar odors and moderate to heavy sheen. Water removed from the well was saturated with a heavy coal tar free-phase product. As a result, no analytical samples were collected.

Well SMW02 was located at the far northwest corner of the ComEd parcel and side-gradient to the interim remedial action implemented by Barr (April 2001) (Figure 5). This well detected less than 1 micrograms per liter (ug/L) of benzene and xylene and only a few PAHs, all of which were below 6 ug/L. Benzo(a)pyrene and benzo(b)fluoranthene were the only organic parameters that exceeded residential groundwater SLs.

Wells SMW04 and SMW05 were located adjacent to, but outside of, the 500,000 Relief Holders/Oil Tanks near the south end of the ComEd parcel. These wells occur within areas where visual and olfactory observations indicate the presence of tar in the fill and within clay fractures. They exhibited elevated concentrations of BTEX (benzene 15,000 ug/L to 19,000 ug/L). PAH concentrations were less consistent. SMW05, located adjacent to but upgradient of the eastern 500,000 Relief Holder/Oil Tank detected a number of PAHs and SVOCs but only exceeded residential groundwater SLs for dibenz(a,h)anthracene (0.3 ug/L) and phenol (1,000 ug/L). SMW04, located adjacent to and downgradient of the western 500,000 Relief Holder/Oil Tank exceeded residential groundwater SLs for most PAHs and SVOCs detected, including 6,800 ug/L of naphthalene (Figure 28).

Temporary wells SB04/PZ01 and SB03/PZ02 were installed within the 500,000 Relief Holders/Oil Tanks. Neither boring encountered visual or olfactory evidence of MGP residuals and the groundwater samples were at or below detection limits for SVOCs and PAHs. SB04/PZ01 exceeded residential groundwater SLs for benzene.

Downgradient of the former MGP operations, four monitoring wells were installed on the LaSalle-Chestnut parcel (SMW01 through SMW04). All four wells detected BTEX compounds with benzene the only parameter exceeding residential groundwater SLs with concentrations ranging from 16 ug/L to 71 ug/L. The three wells located along the ARA (SMW01, SMW03 and SMW04) detected no SVOCs. All PAHs

were at or below detection limits. Well SMW02, located closer to the former MGP operations adjacent to Kingsbury Street detected a number of PAHs and SVOCs but only dibenz(a,h)anthracene (3 ug/L) and naphthalene (1,200 ug/L) exceeded the residential groundwater SLs.

Also downgradient of the former MGP operations, one temporary monitoring well was sampled on the Division-Halsted parcel (PZ01). BTEX, PAHs and SVOCs were near or below detection limits. One PAH, dibenz(a,h)anthracene (0.41 ug/L) exceeded its residential SL.

Additional temporary monitoring wells were installed downgradient of the ComEd parcel on the Halsted property and adjacent Division-Halsted parcel during a Phase II investigation (Clayton, November 1999; ECS, February 2011). The November 1999 and February 2011 groundwater sample locations on the Halsted parcel included borings B-2, SP-2, SP-5, SP-11, SP-12, and SP-14. Groundwater samples from SP-2 and SP-12 were analyzed for PCBs and pesticides all of which were below detection limits. All five samples were analyzed for VOCs. SP-14 along Kingsbury Street was the only well detecting relatively low levels of BTEX, and benzene (75 ug/L) at that location exceeded the residential groundwater SL. The wells were below detection limits for all other VOC compounds. Few PAHs were detected at relatively low concentrations (15 to 29 ug/L) but above the residential groundwater SLs. These parameters included benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene chrysene, and indeno(1,2,3-cd)pyrene. Naphthalene (1,200 ug/L) and 2-methylnaphthalene (160 ug/L) were only observed in SP-14. The Clayton and ECS analytical data are provided in Appendix H.

3.7.4.2 Cyanide

As previously discussed, all surface soil and subsoil samples were below the residential soil SL for cyanide. Total cyanide concentrations found in groundwater are shown on Figure 29. Total cyanide was below detection limits in upgradient wells MW4 and SMW03. Concentrations increased above residential groundwater SLs (200 ug/L) along Kingsbury Street in ComEd SMW02 (1,360 ug/L) and LaSalle-Chestnut SMW02 (1,260 ug/L). Three other samples along Kingsbury between these two points had relatively low concentrations of total cyanide, ranging from 7.5 ug/L to 130 ug/L. Sample locations farther downgradient along the ARA ranged from 42 ug/L to 270 ug/L with two samples exceeding SL values.

3.7.4.3 Metals

Many metals exceeded residential SLs at the well SP-2 on the Halsted parcel, including a high concentration of lead (12,000 ug/L). With few exceptions, remaining metals were below detection limits and/or residential groundwater SLs at all other sample locations.

The distribution of lead concentrations in groundwater is shown on Figure 29. Lead was below detection limits at most sample locations on the ComEd parcel and all well locations on LaSalle-Chestnut. The residential groundwater SL (7.5 ug/L) was exceeded in the ComEd wells within the 500,000 Relief Holders/Oil Tanks, upgradient well MW-4, at all locations on the Halsted parcel and in Division-Halsted well SP-5 along Kingsbury Street at concentrations between 17 ug/L and 100 ug/L. The anomalously high concentration of lead (12,000 ug/L) was detected at SP-2 along Halsted Street, suggesting a more local source. Lead also exceeded the residential soil SL at a number of borings on the Halsted parcel.

An anomalously high concentration of antimony (12 ug/L), above the residential SL (6 ug/L), was detected in ComEd well SMW02 where elevated cyanide also exceeded the residential SL (Figure 29).

Arsenic only exceeded the residential soil SL at scattered surface soil and subsoil locations, and groundwater concentrations were below detection limits in all wells on the ComEd and LaSalle-Chestnut parcels (Figure 30). Concentrations of arsenic in wells on the Division-Halsted and Halsted parcels were near or slightly above the residential groundwater SL (10 ug/L), except at Halsted well SP-2, where the arsenic concentration was quite high (470 ug/L) and coincides with the elevated lead concentration that was found in groundwater at the same location. Arsenic concentrations in soil around Halsted well SP-2 also exceeded the residential SL (SP-1, SP-10 and SP-3).

3.7.4.4 Remedial Natural Attenuation (RNA) Parameters

Several wells have been sampled for RNA parameters. Elevated concentrations of several RNA parameters and the occurrence of styrene in groundwater suggest degradation of organic constituents may be occurring. However, background concentrations of the inorganic RNA parameters have not been established to enable discussion of natural attenuation.

3.7.5 Surface Water Quality

No known surface water sampling has been conducted in the ARA. The entire Chicago River system is suitable for secondary contact use and therefore is not suitable for potable water consumption pursuant to 35 IAC, Part 303.

3.7.6 Sediment Quality

Sediment quality in the ARA has not been fully investigated. Limited sediment investigation activities were conducted in the ARA during October 2006 and March 2007. TarGOST probes and boring locations are shown on Figure 32.

Review of the TarGOST logs suggests the potential presence of NAPL in the ARA sediments at the following locations and depths:

TarGOST Location	Depth Intervals (feet) [1]	Signal (Maximum %RE) [2]
NS-TG004	12 to 13	Low to moderate (39%)
	19 to 20	Moderate (55%)
NS-TG006	10 to 11	Low (24%)
NS-TG0016	11 to 12	Low to moderate (34%)
	19 to 27	Low (24%)
NS-TG0023	13 to 14	Moderate (42%)
NS-TG0025	12 to 13	Low to moderate (31%)
NS-TG0026	13 to 15	Low to moderate (28%)
NS-TG0033	12	Low (24%)

[1] Feet below sediment surface.
[2] % response relative to a known fluorescence emitting reference (RE) material.

TarGOST probe locations NS-TG004 and NS-TG006 are located along the seawall at the southwest corner of the LaSalle-Chestnut parcel. This location coincides with a sewer concrete bulkhead (Figure 32).

TarGOST probe locations NS-TG0023, NSTG0025 and NSTG0026 are located along the seawall near the northwest corner of the LaSalle-Chestnut parcel. These probe locations coincide with a former 36 inch sewer and two (12" and 16") former plant water pipelines.

The three sediment borings conducted in this area (RSB-001, -002 and -003) ranged from 12 to 16 feet below the sediment surface. The borings encountered grey organic silt with trace clay and traces of animal hair. The silt is underlain by medium stiff grey clay.

Each sediment boring encountered visual and olfactory indications of tar (i.e. sheen, odor) within several feet below the mudline and tar at 7 to 9 feet below the mudline. The tar was typically directly above the

clay unit. Each boring penetrated 3 to 5 feet into the underlying clay unit where there was no evidence of tar. PID readings in the clay were 0.

Results of the chemical fingerprinting analyses performed by META on samples collected from the sediment borings indicated the following:

Field Identification	Depth (Feet)	Observations	Class	Tentative
NS-RSB003-001	8.5-9.0	Wide range parent PAH distribution dominated by 2- and 3- ring PAHs indicating minimal weathering; total PAH =2,380 ppm; low level alkanes and sesqueterpane biomarkers; UCM present; Fl/Py ratio = 0.709	Pyrogenic / petrogenic	Tar, likely from a CWG process; some urban background present
NS-RSB001-002	8.7-9.2	Sample similar to *NS-RSB003-001*; total PAH =3,110 ppm; low level alkanes and sesqueterpane biomarkers; UCM present; Fl/Py ratio = 0.626	Pyrogenic / petrogenic	Tar, likely from a CWG process; some urban background present
NS-RSB002-001	9.0-9.4	Also Similar to *NS-RSB003-001*; total PAH =2,580 ppm; low level alkanes and sesqueterpane biomarkers; UCM present; Fl/Py ratio = 0.656	Pyrogenic / petrogenic	Tar, likely from a CWG process; some urban background present

[1] - qualitative identification based on GC/FID and GC/MS data; the identified source refers to the hydrocarbon portion of the sample

A "tar" designation does not necessarily mean the presence of a non-aqueous phase liquid (NAPL), but rather that the PAH pattern and concentrations are consistent with tar or tar-impacted soil or sediment; the most abundant type of material in the sample is listed first.

CWG – carbureted water gas
FID – flame ionization detector
GC – gas chromatography
MS – mass spectrometry
PAH – polycyclic aromatic hydrocarbon
ppm – parts per million
UCM – unresolved complex mixture

All three samples show very similar characteristics in both the GC/FID fingerprints and the diagnostic ratios. The double ratio plots show a very tight grouping both with each other, as well as with known CWG tars from META's reference library. According to META, these three samples appear to have come from the same source.

The petrogenic material present in all the samples appears to consist of varying amounts of weathered middle and heavy distillates (e.g., kerosene and diesel-range) and higher boiling products (e.g., No. 6 fuel oil and asphalt). It was not possible to definitively identify the source of these materials with this data set,

but the material appears similar in all three samples. This material is consistent with the composition of sediments affected by urban runoff.

3.7.7 Soil Gas Quality

No soil vapor sampling has been conducted on the North Station OU. Buildings are located on the ComEd and Old Town Village West parcels only and include a substation control room, a maintenance building, two oil pump houses, and residences. The substation control building is located directly over a former 750,000 gallon oil tank. The maintenance building is located over an oil tank/gas relief holder on the south end of the ComEd parcel. The remaining buildings are not located over any former MGP structures. Buildings are discussed in more detail in Appendix E. Additional soil gas evidence will be gathered to evaluate VI at buildings on properties adjacent to the OU.

3.7.8 Summary of Current Conditions

3.7.8.1 Upland Areas

The upland investigations identified and delineated affected soil and groundwater associated with operation of the former MGP. Results of upland investigations include the following:

- Stratigraphic units identified at the OU included surficial fill and brown/gray clay till. The surficial fill is previously disturbed material, 0 to 12 feet in thickness, and consists of mostly gravel and sand with smaller amounts of silt, clay, bricks, cinders, coal, glass and wood. Underlying the fill unit is native brown/gray silty clay till. The clay unit consists of a medium to stiff clay with silt and trace amounts of fine gravel. The unit is generally encountered from 1 to 12 feet bgs and has a lithologic thickness of greater than 36 feet.

- Bedrock was not encountered in any of the borings. Regional information suggests the depth to bedrock is approximately 50 feet bgs. Bedrock underlying the OU is Silurian-age Niagara dolomite.

- Saturated conditions within the fill may be seasonal. When present, groundwater in the fill appears to be perched at the interface with the clay till. Depths to groundwater in the fill will depend on the fill thickness and/or depths to the clay till. The clay till exhibits low vertical hydraulic conductivity on the order of 10-7 cm/sec to 10-8 cm/sec, based on Shelby tube samples. However, the clay is fractured which allows for potential migration of MGP residuals horizontally and at depth.

- Groundwater flows west to southwest towards the North Branch of the Chicago River which is the likely discharge area of relatively shallow groundwater from the OU. During periods of elevated river stages, it is probable that groundwater flow directions will reverse temporarily and the North Branch of the Chicago River will recharge the shallow groundwater.

- MGP residuals generally occurred across the OU at the shallow perched water table and interface of the surficial fill material with the underlying clay unit. Deeper soil and groundwater exhibited tar-saturated soil and tar within clay fractures around a buried oil tank on the north end of the ComEd parcel and around the two 500,000 ft3 Relief Holders/Oil Tanks. A number of samples were analyzed below these zones of tar saturated soil which suggest MGP residuals are possibly limited to depths less than 40 feet bgs.

- Upgradient of the ComEd parcel east of Crosby Street, numerous historical USTs (not associated with MGP operations) along Elm Street exhibited visual and/or olfactory evidence of releases that appear to be limited in extent.

- MGP residuals extend westward from the ComEd parcel along Kingsbury Street where evidence varied from tar-stained soil and sheens to visible coal tar in fractures within the clay unit. Olfactory observations of MGP residuals indicated the most affected areas were downgradient of the Tar Tank/Buried Oil Tanks (3) to the north and downgradient of the tar settling tanks and western 500,000 ft3 Relief Holder/Oil Tank to the south. Between these areas, there appears to be a continuous sheen at the water table along Kingsbury. These conditions also extended relatively short distances onto the parcels immediately west of Kingsbury, namely the LaSalle-Chestnut, Division-Halsted and Halsted parcels.

- The Halsted parcel's prior land use for coal storage confounds interpretation of the presence of MGP residuals in surface soils and subsurface soils. PAHs above residential soil SLs are indigenous to the fill in the area. In addition, the property exhibits elevated concentrations of lead and antimony that do not appear to be related to the former MGP operations.

- The existing data do not allow evaluation of the potential impact of shallow underground utility lines below Kingsbury and Hobbie Streets to intercept groundwater containing MGP residuals from the OU and act as preferential migration pathways. A ComEd tunnel, MWRD deep tunnel structure and City outfall sewer occur on the LaSalle-Chestnut parcel and sufficient investigation has been performed to demonstrate that preferential migration of MGP residuals is not occurring along these structures.

- Limited remedial actions have been conducted by ComEd in three localized areas on the OU related to construction of substation infrastructure. Access to former MGP structures that are likely to be sources of MGP residuals in order to perform further investigation and/or remedial action is limited by safety restrictions within the substation.

- Remedial action activities were completed on the LaSalle-Chestnut parcel in which soil was excavated to the depth of visible MGP residuals, six inches below water table or to a maximum depth of 10 feet bgs and transported to an Illinois-approved landfill. The excavations were backfilled with imported, clean backfill. While confirmation samples indicated that Illinois EPA residential and construction worker remediation objectives were sufficiently achieved, the multi-site residential soil SLs for various PAHs were exceeded in roughly one-third of the floor areas sampled.

- Remedial action activities were also completed on the Old Town Village West parcel in which limited soil was removed along with placement of engineered barriers to address soil ingestion pathways. This property received NFR letters from Illinois EPA.

- PAH concentrations in surface soils (0 to 4 feet bgs) exceed residential soil SLs. Compounds commonly exceeding PAH SLs were those with relatively low residential screening values,

including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene. Naphthalene tended to show SL exceedances only in samples near visibly affected subsurface soils. VOCs related to the former MGP were not detected in any surface soil samples, potentially due to the high permeability of the fill, the absence of surface barriers that would inhibit volatilization and/or placement of new fill since MGP operations ceased.

- PAH concentrations in soils exceed industrial soil SLs at locations throughout the study area. Compounds commonly exceeding PAH SLs were those with relatively low residential screening values, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene.

- The available groundwater quality data suggest the occurrence of MGP residuals is most significant in the area of the former tar settling tanks and 500,000 ft3 Relief Holders/Oil Tanks on the south end of the MGP operations on the ComEd parcel. Soil boring log observations also indicate areas of concern on the north side of the former MGP operations as indicated by the presence of coal tar in soil and monitoring well MW-1 near the former tar and oil tanks and the 1.5M ft3 Gas Holder. West of Kingsbury Street, the observed BTEX and PAH concentrations decrease to levels approaching residential groundwater screening values. Exceedances are typically limited to benzene and a few PAHs, including benzo[a]anthracene, benzo(a)pyrene, benzo(b)fluoranthene and benzo(k)fluoranthene.

- Arsenic exceeded residential soil SLs in surface and subsurface soils primarily in the northwest corner of the ComEd parcel, the Kingsbury Street ROW, the north end of LaSalle-Chestnut, and scattered throughout the Division-Halsted and Halsted parcels. Arsenic was below detection limits and/or residential screening values in all groundwater samples.

- MGP-related metals do not appear to be a concern on the OU. While no surface or subsurface samples exceeded residential soil screening values on the OU (excluding arsenic), lead was the only parameter found in groundwater exceeding the residential groundwater screening values.

- Total cyanide was below residential soil screening values in all surface and subsurface samples analyzed. While total cyanide exceeded residential groundwater SLs in four samples collected on downgradient parcels, no analyses had been performed for available cyanide. Wells upgradient of the former MGP exhibited total cyanide concentrations below detection limits.

3.7.8.2 North Branch Canal of the Chicago River

The investigations conducted in the ARA identified the presence of residuals associated with operation of the former MGP. Results of these investigations include the following:

- TarGOST probes suggested the possible presence of NAPL at near shore locations adjacent to the LaSalle-Chestnut parcel that coincide with an existing City sewer outfall and former MGP sewers and pipelines;

- Three borings performed in the ARA sediments in the vicinity of the former MGP sewers and pipelines encountered organic silt with trace clay underlain by the natural clay unit. The

borings also encountered tar at depths of 7 to 9 feet below the sediment surface at the sediment/clay unit interface;

- Analysis of three sediment samples exhibiting coal tar were identified as being derived from a CWG process along with the presence of some urban background PAHs; and
- The magnitude and extent of MGP residuals in the sediments adjacent to the OU have not been defined.

3.8 Constituents of Potential Concern

The site-specific COPCs are based on an evaluation of the COPCs found in the Multi-Site Conceptual Site Model (CSM) (Integrys 2007a) and Multi-Site Risk Assessment Framework (RAF) (Exponent 2007) along with data collected on the OU and knowledge of historic land use. Environmental samples of soil and groundwater were collected during previous investigation and remedial activities (Sections.2.6 and 2.7). Constituents consistently not detected in these previous samples are not considered COPCs for the North Station OU.

Previous samples collected on site were analyzed for one or more of the following: VOCs or BTEX, SVOCs or PAHs, phenols, motor oil, diesel range organics (DRO), gasoline range organics (GRO), total petroleum hydrocarbons, pesticides, metals, and cyanide.

Site-specific selection of COPCs is partially based on current and former land use. As described in the Completion Report (2011) and Section 2 of this SSWP, the MGP facility was constructed in 1868 and was closed in the early 1960s. The MGP was located on what is now called the ComEd parcel. PGL coal storage occupied the LaSalle-Chestnut and Division-Halsted parcels, and PGL office and pipe galvanizing operations occupied the Old Town Village West parcel. Notable uses of the Old Town Village West parcel since PGL occupied the site include use by various businesses, such as a lumber yard, automobile maintenance/repair garages, junkyard, metal and die cutting shop, sign factory and various manufacturing facilities and factories.

Currently, portions of the OU are being used as an electric utility substation (ComEd parcel); a laydown area for heavy equipment/crane parts (Division-Halsted parcel); vacant land (LaSalle-Chestnut parcel); and residential apartment buildings (Old Town Village West parcel).

Analyses of the historic site data and details regarding the selection of the site-specific COPCs are presented in Appendix D (soil, groundwater, sediment and surface water) and Appendix E3 (soil vapor). The results are summarized below and site-specific COPCs are listed in Table 1.

Soil COPCs – As discussed in Subsection 2.7, former MGP structures and impacted soil were removed from the ComEd, LaSalle-Chestnut, and Division-Halsted parcels of the North Station OU. Partial remediation and installation of an engineered barrier related to redevelopment was carried out on the Old Town Village West parcel. Confirmation soil samples were collected following the LaSalle-Chestnut remediation, and limited confirmation sampling was conducted on the ComEd parcel. Additional soil investigation and sampling has been conducted on the Division-Halsted and ComEd parcels, the off-OU Halsted parcel, and in Kingsbury, Hobbie and Crosby Streets surrounding the former MGP facility. Limited soil investigation data is available for the remediation work done on the Old Town Village West parcel. Data from these previous sampling events were used to develop site-specific soil COPCs.

Based on the analysis documented in Appendix D, different site-specific COPC lists have been developed for the parcels on the OU and the parcels off the OU. Soil samples collected for the Remedial Investigation (RI) on the ComEd, Division-Halsted, and LaSalle-Chestnut parcels and in the Kingsbury, Hobbie and Crosby Streets ROWs will be analyzed for a site-specific list of COPCs based on a modified version of the multi-site RAF MGP COPC list. The modified list includes the petroleum VOCs (PVOCs), PAHs, 2-methylnaphthalene, dibenzofuran, total arsenic, total lead, and PCBs. Soil samples collected for the RI on the Old Town Village West parcel will be analyzed for all constituents on the multi-site RAF MGP COPC list, in addition to TCL VOCs and PCBs. Soil samples collected for the RI on the off-OU properties, the Halsted and Division parcels, will be analyzed for all constituents on the multi-site RAF MGP COPC list, in addition to PCBs.

The inclusion of non-MGP related constituents such as PCBs and expanded list VOCs on the COPC lists is intended to be used to evaluate soil quality on the OU, and not necessarily to define the extent of distribution of non-MGP contaminants.

Groundwater COPCs – No groundwater monitoring has been conducted on the OU since remediation activities were completed on the LaSalle-Chestnut and ComEd parcels. In addition, only one round of groundwater samples have been collected anywhere on site. Based on the analysis documented in Appendix D, groundwater across the site will be analyzed for the same constituents as those selected for the site-specific soil COPC list to be used for on-OU parcels and adjacent ROWs. In addition, based on the occurrence of additional constituents in historic groundwater samples, total antimony, available cyanide, phenol and styrene will be included on the COPC list for groundwater (Table 1).

The groundwater COPC list will be re-evaluated based on results from proposed soil sampling. Historic and new soil sampling results will be re-evaluated for COPCs using the process described in Appendix D, and groundwater COPCs will be modified to incorporate changes to the soil COPCs. In addition, for

groundwater sampling events beyond the first two, groundwater analytical results will be evaluated to determine if the groundwater COPC list can be modified through the process put forth in the Multi-Site CSM. If an analyte does not exceed the residential SL for two rounds of sampling, it will be removed from the site-specific COPC list for groundwater.

Sediment COPCs – Based on the analysis documented in Appendix D, sediment samples will be analyzed for all constituents on the multi-site RAF MGP COPC list (including alkylated PAHs in certain instances). Based on the results of the Step I sediment sampling, the site-specific sediment COPC list may be modified in a manner mutually agreed-upon with United States Environmental Protection Agency (USEPA). More information on Step I sediment sampling can be found in Section 6.6.6.

Surface Water COPCs – Based on the analysis documented in Appendix D, surface water samples will be analyzed for all constituents on the multi-site RAF MGP COPC list. Ambient surface water quality will also be established and is discussed in more detail in Section 6.6.3.

Soil Gas COPCs – No soil vapor samples have been collected to date. Based on the analysis documented in Appendix E3, soil gas samples collected during implementation of this SSWP will be analyzed for the standard list of vapor intrusion (VI) COPCs for Integrys MGP sites, plus 16 additional constituents; 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, 1,1-dichloroethane, 1,1-dichloroethene, 2-hexanone, 4-methyl-2-pentanone (MIBK), acetone, bromodichloromethane, bromomethane, carbon disulfide, chloroethane, chloroform, chloromethane, methyl ethyl ketone, methylene chloride, and styrene.

An OU-specific summary of the Sampling and Analysis Plan is provided on Table 2. Table 2 also includes analytical data and geotechnical testing needed to support the FS.

4 SITE-SPECIFIC CONCEPTUAL SITE MODEL SUMMARY

A Site-Specific CSM was developed for the North Station OU (Figure 33), which is based on the Multi-Site CSM (Integrys 2007a). The Site-Specific CSM was refined to reflect conditions observed during the reconnaissance activities completed on July 19, 2009, and information summarized in the Completion Report (NRT 2011). The Site-Specific CSM provides the framework to identify data needs to characterize the North Station OU and evaluate potential human health and ecological risks. The Site-Specific CSM and risk assessment approach will be routinely reviewed to refine the media of concern and individual pathways as more data are collected.

4.1 Site Reconnaissance

A site reconnaissance was completed on July 19, 2011 at the North Station OU. During the reconnaissance, observations were made of site conditions to understand which contaminated media human and ecological receptors might have the potential to be exposed and will require evaluation within the BLRA. The ecological check list provided in the RAF was also filled out and photographs taken to document site conditions (refer to Appendix A7). Additional information regarding conditions on the North Station OU is contained in the Completion Report (NRT 2011) and was used along with the observations made during the reconnaissance to develop the Site-Specific CSM. As part of the RI, additional reconnaissance activities will be performed and the habitat assessment field forms for the ARA will be updated if necessary, as the ARA could only be observed from the upland portion of the site during the reconnaissance. The additional observations that will be made of the ARA during the RI will include the general habitat characteristics of the ARA in the area of the North Station OU, which are more readily observed while performing the sediment investigation.

The OU is zoned by the City of Chicago for manufacturing land use. The OU is composed of the ComEd electrical substation with associated buildings and towers (ComEd parcel), vacant land that is currently being used as a parking area (N. Kingsbury Street), additional vacant land used (LaSalle-Chestnut parcel), a storage yard for construction equipment (Division-Halsted parcel), and residential property (Old Town Village West parcel). Other than the Old Town Village West parcel, that is covered with residential buildings and landscaped yards around the buildings, the parcel surfaces are covered primarily by gravel, with no apparent landscaping, and limited paving (Figure 21). Access to all but N. Kingsbury Street and

portions of the Old Town Village West parcel is limited by fencing and gates. The ComEd facility fencing also includes razor wire at the top of the fence to deter unauthorized entrance into the substation.

Buildings related to operation of the substation are present on the ComEd parcel, including buildings used for storage, maintenance and protection for equipment (i.e. pump houses and control building). Additional information about occupancy and use of the buildings has not yet been made available by ComEd. Occupied apartment buildings are located on the Old Town Village West parcel. There are no other building structures on the OU.

As discussed previously, the LaSalle-Chestnut parcel was previously remediated by excavation. Clean imported gravel aggregate was used to backfill the excavated areas and remains in place today. Partial remediation was also conducted on the Old Town Village West parcel, followed by installation of an engineered barrier of clay and topsoil or a building foundation.

At present, the area surrounding the OU includes new residential property developments to the east and east. The adjacent Halsted parcel to the west is zoned manufacturing and is part of the construction equipment storage yard also located on the Division-Halsted parcel. Planned development and planned manufacturing is located further to the west across the North Branch of the Chicago River. Figure 4 presents the OU and surrounding area zoning as obtained from the City of Chicago Planning and Zoning Bureau website on June 12, 2011.

The owner of the LaSalle-Chestnut property reported to B&McD that the future land use is expected to be residential condominiums. A considerable amount of residential redevelopment is also occurring in the surrounding area and zoning is expected to change to reflect this trend (B&McD, June 2006). However, the LaSalle-Chestnut, Division-Halsted, and ComEd parcels are all significantly occupied by utility and infrastructure elements and related setbacks that would make development difficult. Overhead and buried power lines dominate the ComEd parcel and overhead power lines cross the LaSalle-Chestnut and Division-Halsted parcels. In addition, a large diameter storm sewer and an approximately 42-inch diameter drop shaft that accesses the Metropolitan Water Reclamation District of Greater Chicago (MWRD) deep tunnel are located on the southern portion of the LaSalle-Chestnut parcel.

A habitat assessment was conducted on the active urban upland portion of the OU on July 19, 2011 by an Exponent environmental toxicologist during a visit to the OU. Observations were made from properties for which there was access on the day of the site visit including N. Kingsbury Street and public ROWs (refer to Appendix A7). There was no ecological habitat in or adjacent to the upland area of the OU due to the extensive urban development. The upland portion of the OU is composed of parcels that are developed and the ground surface is primarily covered with gravel with limited vegetation other than some

weed species and trees growing in isolated patches along fence lines. The only parcel with significant vegetation is the Old Town Village West parcel, but the vegetation is not natural, but rather consists of landscaped yards with ornamental plant species that does not afford ecological habitat. No terrestrial ecological receptors were observed on the OU during the site visit.

A complete habitat assessment of the ARA could not be completed during the site reconnaissance due to the limited access to the ARA. A more formal habitat assessment will be completed during the North Station sediment investigation, however during the site reconnaissance, the general condition of the ARA and riverbank was observed and initial observations of ecological receptors using the ARA were made. The ARA is constrained by vertical walls or steep rocky banks and there is very limited vegetation in the riparian zone. The vegetation present on the banks is limited to isolated clumps of deciduous trees or weed species along the Division-Halsted Parcel (see photos in Appendix A7). Waterfowl (mallard ducks and Canada goose) were observed in the ARA, but no other aquatic ecological receptors were observed in the ARA on the day of the reconnaissance. There is limited nesting habitat for birds on the OU or adjacent properties because of the limited vegetation presents.

The ARA is generally 4 to 8 feet deep as reported in the Completion Report (NRT 2011). However, in the area of the OU, the center channel of the ARA is very deep (greater than 10 feet deep) based on elevation information collected at three sediment borings (Appendix B of the Completion Report [NRT 2011]).

Reconstruction of the Halsted Street bridge was on-going just upstream of the OU on the day the reconnaissance was performed.

The primary purpose of the additional ARA reconnaissance mentioned above is to further evaluate whether the exposure pathways established as complete for human and ecological receptors in the following sections are valid. If additional information is obtained during the RI that would suggest exposures to other receptors are occurring, further assessment of these exposure pathways will be addressed in the BLRA.

4.2 Media of Potential Concern

The Multi-Site CSM (Integrys 2007a) considered the following as media of potential concern for the North Station OU:

- Surface and subsurface soil;
- Surface water;

- Groundwater;
- Sediment; and
- Soil vapor.

The River is designated as a Secondary Contact and Indigenous Aquatic Life waterway by the Illinois Pollution Control Board in 35 IAC, Section 303.441. This designation indicates that flow is presumed to be dominated by treated municipal effluents. The media of potential concern will be evaluated as part of the risk assessment to review if response actions, including risk management tools, are warranted to manage the potential risk to human health and the environment on the North Station OU.

The risk assessment of the media of potential concern will be based on existing data and new data to be collected as described in Section 6 of this document and in the Site-Specific Quality Assurance Project Plan (QAPP) (Appendix B1). Previously collected data has been assessed for data quality in SSWP Section 2.6.7, and further assessment of the data will be done prior to using data as part of the RI per the guidelines in the Site-Specific QAPP (Appendix B1). Additional data assessment will consider the age and quality control procedures of the data, detection limits, and the likelihood that the data are still representative of current conditions. Representative data to be used for site evaluation are those that likely still present on the OU; therefore, any historic data that represent soil that has been removed from the OU are no longer considered representative. In addition, historic groundwater data are not considered completely representative of current conditions because several years have passed and soil remediation was conducted since the time of the last groundwater sampling event. The data assessment will include a comparison with newly collected RI data according to evaluation criteria located in the Site-Specific QAPP.

As a referenced, the COPCs for each media are discussed in Section 3.8. An analysis of the site historic data and details regarding the selection of the site-specific COPC lists are presented in Appendix D (soil, groundwater, sediment and surface water) and Appendix E3 (soil vapor), and the results are summarized in Table 1.

4.2.1 Surface Soil

Surface soil was removed during previous remedial actions from the LaSalle-Chestnut, ComEd, and Old Town Village West parcels. Surface soil removal is discussed in Subsection 2.7 and summarized here:

- Small areas of surface soil were removed from the ComEd parcel to facilitate installation of the utility infrastructure. Fill and gravel were used to backfill excavated areas.

- All surface soil on the LaSalle-Chestnut parcel was removed and backfilled with granular fill during remediation.
- All surface soil on the Old Town Village West parcel was either covered with compacted clay and topsoil (total of 1.5 feet of cover) or covered by building slabs/foundation during remediation and redevelopment of the property.

A large portion of the OU where surface soil was not removed is covered by gravel, structures (i.e., towers), equipment (e.g., transformers) and buildings and a large portion of the OU is generally not accessible due to safety concerns (i.e., the 5.5 acre ComEd substation).

Surface soil will be evaluated as a medium of potential concern because of the potential for current or future occupants to be exposed to surface soil. Surface soil sampling is proposed at locations across the study area (Figure 34 and Tables 2 and 3). The excavated surface soil on the LaSalle-Chestnut parcel was replaced with imported backfill, which was sampled and established as un-impacted virgin material. Excavated surface soil on the Old Town Village West parcel was backfilled with a clay layer and topsoil, or a building was constructed on top of the area. No surface soil sampling is proposed in these areas because the surface soil has been replaced by fill. Near-surface soil samples are proposed for collection across the ComEd parcel in areas where previous excavation has not been completed. Near-surface soil samples on the ComEd and Old Town Village West parcels will be collected from soil beneath the surface gravel cover. Additional surface soil samples will be collected from borings proposed on the remaining parcels if the boring location is unpaved and open (Division, Halsted, and Division-Halsted parcels). If the boring is located in a paved or gravel-covered area, a near-surface soil sample will be collected below the cover. All sampling locations will be attempted provided underground utilities are not present and the surface is not backfill or imported material to better define the surface soil conditions. If field conditions restrict placement of a boring in a proposed location, the boring will be executed as close to the proposed location as possible at a position mutually agreed upon by the field team. The surface soil data will be used within the BLRA to evaluate the potential human health risks associated with this medium.

Surface soil will be collected from 0-6 inches bgs at locations where surface soil is not covered by fill, pavement, or other material. Soils from this horizon will be defined as true surface soils for purposes of the risk assessment because people would have the greatest potential to be exposed to these soils under current conditions. In addition, at 50% of the surface soil sampling locations, a second near-surface soil sample will be collected from 6-24 inches bgs. People will have less potential to be exposed to these near surface soils, but under certain conditions exposure to near surface soils may be possible (e.g. non-commercial activities like home gardening). The surface soil and near-surface soil samples will be used together to characterize potential exposure and risk to a range of human receptors in the BLRA.

If there is pavement or gravel at the surface, then a true surface soil sample will not be able to be collected. At locations where ground cover, such as gravel, is present, near-surface samples will be collected from the first 0-6 inches below the cover layer. People will have less potential to be exposed to these covered, near-surface soils, but under certain conditions exposure to these soils may be possible.

4.2.2 Subsurface Soil

Subsurface soil located either at or below 2 feet bgs or beneath pavement will be evaluated as a medium of potential concern because past investigations have detected DNAPL/Tar and LNAPL/sheen in soil borings within each of the parcels (Figure 34 and Tables 2 and 3). Subsurface soil sampling has been conducted throughout the OU during previous investigations. Additional data collection for the RI is proposed for non-fill material encountered on the Old Town Village West (borings NOS-SB104 and 105) and Division parcels (north of the ComEd parcel, borings NOS-SB101 to 103), and at locations throughout the study area where wells and probes will be installed.

Humans are be less likely to be exposed to subsurface soils because it is normally inaccessible to them. However, if redevelopment occurs, construction workers could be exposed to the subsurface soils. In addition, if subsurface soils are brought to the surface during redevelopment, the potential for exposure to these soils by other human receptors increases. For these reasons, subsurface soil data will be used to evaluate potential risks to a range of human receptors in the BLRA.

4.2.3 Surface Water

Surface water in the ARA will be evaluated as a medium of potential concern (Figure 35 and Table 2). Surface water samples have not been previously collected. Investigations are needed as described in Section 6.6 to assess surface water quality and to evaluate both potential human health and ecological risks.

4.2.4 Groundwater

Groundwater will be evaluated as a medium of potential concern. Based on historical site investigation activities, groundwater on the North Station OU flows generally west toward the River. Groundwater samples collected from groundwater monitoring wells indicated impacted groundwater on the OU prior to remediation activities; however, no groundwater monitoring has been conducted since remediation activities were completed. Groundwater monitoring wells will be installed at the OU to evaluate general existing conditions and conditions in the areas of former MGP structures on Site (Figure 34 and Tables 2

and 3). The most current two years of groundwater data collected during the RI will be used to evaluate risk associated with contaminants present in groundwater.

4.2.5 Sediment

Sediment in the ARA will be evaluated as a medium of potential concern. Previous investigations indicate the possible presence of MGP residuals and PAHs in the river sediments (Figure 32). Samples consistent with the signature of weathered tar were reported in forensic samples collected approximately 7 to 9 feet below the sediment surface. Further investigations are needed as described in Section 6.6 to assess sediment quality and to evaluate potential risks to ecological receptors (Figure 35 and Table 2).

4.2.6 Soil Vapor

Soil vapor has the potential to be impacted with MGP-related constituents if subsurface soil or groundwater are affected by volatile and toxic MGP-constituents (e.g., naphthalene and PVOCs). Soil gas near or beneath a building structure that becomes contaminated could enter a building through cracks in the foundation floor. Soil gas samples have not been collected on the North Station OU. Soil gas is considered a medium of potential concern related to VI into buildings on the ComEd substation, due to the location of the buildings in relation to the location of former facility structures and identified MGP residuals.

The need for additional soil gas characterization on other site parcels and adjacent to the OU will be assessed based on the results of the proposed RI sampling, including soil and groundwater sampling and collection of exterior soil gas samples. Sampling results that may indicate the need for additional soil gas sampling include the presence of volatile and toxic constituents in soil or groundwater located within a critical distance of occupied buildings or preferential migration pathway. If sampling results indicate the need for additional soil gas assessment, additional probes may be installed near or in building foundations to assess the migration of soil gas into indoor air. Soil gas probes may also be installed in utility corridors to assess preferential migration of vapors or open areas to assess future use scenarios for the property. The decision to install additional soil gas probes will be made based on the results of the subsurface characterization efforts and building characteristics, and if required, may result in the need for another RI field event. Details of the VI assessment can be found in Appendix E.

Additional building information, such as building occupancy; the presence of heating, ventilation, and air conditioning (HVAC); and the presence of basements, sumps, cracks in floor slabs, etc., will be collected when access to the buildings is obtained. This information will be included in the RI report.

Soil vapor, subslab vapor, and sump headspace samples will be collected as grab samples. Proposed VI sampling locations for the study area are indicated on Figure 34 and Table 2.

4.3 Potential Exposure Pathways – Human Health

This section evaluates potential exposure pathways for human health receptors as presented in the Multi-Site CSM (Integrys 2007a). An evaluation of the Multi-Site CSM exposure pathways has been considered to develop the CSM specific to the North Station OU. This evaluation considers both current and potential future land use within the OU. The potential human receptors being evaluated under a range of land use scenarios include industrial/commercial workers, construction workers, recreational visitors/trespassers, and residential.

Exposure pathways will be evaluated as part of the risk assessment activities to assess if response actions, including risk management tools, are warranted to manage the potential risk to human health on the North Station OU. The methods that will be used to evaluate potentially complete exposure pathways are included in the Multi-Site RAF (Exponent 2007).

The public water supply for the City of Chicago is obtained from Lake Michigan; therefore, consumption of groundwater is not expected (Appendix I). In contrast, the water table on the North Station OU is perched creating the potential for dermal exposure during construction activities if contamination exists. The potential for such exposure to groundwater will be further evaluated in the RI/FS. State and federal drinking water standards will be used for informational purposes to evaluate potential risks associated with groundwater ingestion and contact. This evaluation will be documented in the BLRA.

The Illinois EPA Secondary Contact and Indigenous Aquatic Life use designation advises limited direct contact with the surface water within the waterway. Illinois EPA recommends recreational or other water use where contact with the water is limited and the probability of ingesting appreciable quantities of water is minimal. Recommended uses are limited to fishing, commercial and recreational boating (e.g., canoeing and kayaking), and any limited contact incident to shoreline activity (35 IAC 301.380). Currently there is a private boat dock associated with the condominium complex located along North Kingsbury Street south of the OU, which provides access to the ARA directly adjacent to the OU. Also there is a kayak rental facility located approximately one mile upstream of the OU on the west side of Goose Island in the turning basin located just downstream of the Willow/Hawthorne OU. Therefore, this reach of the River may receive more recreational use compared to areas where access is not as available.

SLs used in this SSWP are those presented in the RAF Addendum (Exponent 2011), and include the cancer endpoint values for naphthalene and ethylbenzene.

4.3.1 Industrial/Commercial Land Use Scenario – Worker

The Multi-Site CSM considered the exposure route to the industrial/commercial worker through incidental ingestion, dermal contact, and inhalation of soil due to either direct exposure to surface soil or subsurface soil due to soil disturbance. As stated previously, all accessible impacted MGP soils on the LaSalle-Chestnut Parcels were removed to at least 5 feet bgs and up to 11 feet bgs into native clay. Surface soils on this parcel consist of clean gravel fill material. Residual concentrations of MGP-related constituents in subsurface soil on this parcel exceed residential and industrial SLs at locations scattered throughout the site at depths below the previous remediation excavations. Therefore, the risk of exposure would be present only during excavation or earth disturbing activity to depths below previous excavation. Under these conditions, exposure to subsurface soils may pose a health concern to industrial/commercial workers. In the risk assessment, conditions on site will be documented to explain why soil exposure to MGP-related constituents on this parcel may be considered a complete exposure pathway only at depths greater than the previous remediation excavations.

On the ComEd and Division-Halsted parcels, existing data and data obtained from proposed sampling will be used to evaluate exposures to surface soils by commercial/industrial workers by comparing surface soil concentrations to human health soil SLs provided in the RAF Addendum (Exponent 2011). Surface soil on the LaSalle-Chestnut and Old Town Village West parcels has been removed and replaced with clean fill, so no further evaluation of surface soil will be necessary on those parcels. In the future, if subsurface soil is disturbed (e.g. during construction) on these parcels where the upper layer of soil/gravel/pavement/landscaping is currently serving to prevent exposure to the subsurface, and the subsurface soil remains exposed after the disturbance, exposure to these subsurface soils may be possible. Therefore, industrial/commercial worker exposure to subsurface soils on OU parcels will be further evaluated in the risk assessment to evaluate the potential risk associated with human exposure to subsurface soils.

Exposure to groundwater by an industrial/commercial worker is not expected because the public water supply is obtained from Lake Michigan. However, the groundwater data collected during the RI/FS for the OU will be compared to State and Federal drinking water standards for informational purposes only.

Based on the current land use and presence of buildings and former MGP structures, potential inhalation of vapors from VI into buildings will be evaluated at selected buildings (Appendix E). On the ComEd

parcel, where the former MGP structures were located, there are a number of buildings used as equipment storage, controls, and maintenance (Buildings 1-4, Figure 34). Occupancy details for all the ComEd buildings are not currently available. There are also inhabited buildings on the Old Town Village West parcel and adjacent to the OU parcels along Division Street, North Crosby Street, and West Hobbie Streets (Buildings 5-8, Figure 34) where investigation is proposed. Analysis of additional soil and groundwater data throughout the study area and exterior soil gas data from on the Old Town Village West parcel and at the perimeter of the OU will inform the need for soil gas sampling at buildings located off of the ComEd parcel. In addition, once the extents of MGP-impacted soil and groundwater are established, the potential for VI due to the presence of impacted soil or groundwater will be evaluated on parcels where no current buildings are located to assess future use. Currently, the completeness of the exposure pathway for VI is unknown. Soil gas data, when obtained, will be compared to VI SLs to evaluate if there is a potential risk associated with VI into current or future buildings in the study area.

The industrial/commercial worker receptor will not be further evaluated with respect to sediment and surface water exposures because the River is designated a Secondary Contact and Indigenous Aquatic Life waterway by Illinois EPA. River water is likely not currently used for industrial or commercial processes by businesses located adjacent to the ARA, and exposure of industrial/commercial workers to in-stream contamination is not expected. Due to the general depth of surface water in the ARA (i.e. 4 to 10 feet) within the reach adjacent to the OU and some areas being as deep as 10 feet, the sediments would not be accessible to industrial/commercial workers.

In summary, the industrial/commercial worker scenario on the North Station OU will be assessed using existing data of sufficient quality (as discussed in Section 4.2) and newly collected data to evaluate potential risks under the following exposures:

- Incidental ingestion, dermal contact with or inhalation of surface or subsurface soil on all OU parcels, with the exception of surface soil and subsurface soil down to 3-11 feet bgs on the LaSalle-Chestnut and Old Town Village West parcels where remediation has already been implemented;
- Groundwater ingestion; and
- Inhalation of vapors through VI from soil and groundwater close to or underneath the buildings on the ComEd parcel, near the former PGL building on the Old Town Village West parcel, and in portions of the study area where historic soil or groundwater data has indicated a potential for VI to current buildings. The need for any additional soil gas sampling at current buildings or to consider future use will be evaluated based on soil and groundwater data to be collected during the RI.

4.3.2 Construction Worker

The Multi-Site CSM considered the potential exposure of the construction worker through incidental ingestion, dermal contact, and inhalation of soil during soil disturbance. Consistent with the Multi-Site CSM, there is the potential that construction workers may be exposed to soil if portions of the North Station OU are redeveloped or if subsurface utility work occurs. During this utility work, they may also be exposed to perched groundwater. Under current conditions, the potential may exist for construction workers to be exposed to affected surface water and sediment during construction of in-water utilities. The potential exposure of the construction worker will be qualitatively addressed in the risk assessment due to the short duration of exposure. The assessment of risk to the construction workers will be qualitative in nature in comparison to the potential risks evaluated for other receptors with potentially longer periods of exposure to each environmental media (e.g., outdoor commercial workers [soil], and recreational users [surface water]). The construction worker scenario will be assessed using both previously collected data that meets the required data quality objectives (as discussed in Section 4.2) and new data to evaluate risks under the following exposures:

- Incidental ingestion, dermal contact or inhalation of soil (as well as chemical vapors) during soil disturbance on the OU parcels with un-remediated soil remaining at depths shallower than 10 feet bgs;
- Inhalation of vapors derived from groundwater associated with excavation activities across the site;
- Incidental ingestion and dermal contact with groundwater in excavations from across the site; and
- Dermal contact and incidental ingestion of surface water and sediment during utility construction.

4.3.3 Recreational Land Use Scenario – Visitor/Trespasser

The Multi-Site CSM considers that potential exposure to a recreational visitor/trespasser may occur through incidental ingestion and dermal contact with surface water and sediment. In addition, the indirect exposure of recreational users to MGP-related constituents in sediments due to the consumption of recreationally caught fish was also considered. With the current land use, a visitor/trespasser could contact surface water while boating on the ARA, but direct contact with sediment is not expected because of the water depth (i.e., greater than 4 feet) and shoreline characteristics along the OU (consisting of vertical sheet pile walls). However, the actual depths of surface water adjacent to the site will be verified during the remedial investigation to evaluate if sediment would be accessible or not to recreational

visitors. The nearest area to moor boats is located just downstream of the OU at the condominium complex located directly south of the LaSalle-Chestnut parcel. At this location there is a private dock where boats can be moored by local residents. A recreational boat launch for small watercraft (i.e., kayak rental facility) is located upstream approximately 1 mile to the northwest.

Based on currently available information on the river conditions, wading in the canal is not reasonable due to water depth in the ARA. The ARA channel is approximately 100 feet wide and water depths generally range from 4 to 10 feet, with the center of the canal being even deeper. Steel sheet piling constructs the shoreline along the majority of the riverbank, or the bank is very steep and lined with rock and concrete. During the remedial investigation the depth of surface water will be evaluated to confirm whether sediment exposure is possible or not based on water depth.

The direct exposure routes considered for the recreational land use scenario along the North Station OU include those consistent with the Multi-Site CSM. In the case of the North Station OU, recreational exposure to surface water is expected to occur; however sediment contact is not expected due to the depth of the water. Depth of water will be verified during the RI. Using data obtained from the proposed surface water and sediment sampling, the potential risks associated with recreational land use exposures will be evaluated as follows:

- Incidental ingestion of surface water; and
- Dermal contact with surface water and sediment.

Recreational fishing is a potential indirect route of exposure to contaminants present in river sediments. The Illinois Department of Natural Resources (IDNR) has issued a fish consumption advisory for carp, bass, and sunfish for the Chicago River system due to polychlorinated biphenyls that are unrelated to the former MGP activities. As discussed in the Multi-Site RAF (Exponent 2007), fish consumption is not a primary exposure pathway for humans associated with MGP-related constituents because fish metabolize PAHs and other MGP constituents, so they generally do not bioaccumulate in fish. Exceptions to this rule are the specific metals that were identified in the Multi-Site RAF. For these reasons, fish consumption is not expected to be a significant exposure pathway to MGP-related constituents. However, the sediment data will be evaluated to determine if MGP-related constituents that are known to bioaccumulate are present and whether fish should be assessed further as an exposure pathway.

A site-specific exposure assessment for recreational use of the ARA will be developed consistent with the RAF as part of the BLRA. Based on that exposure assessment and the surface water and sediment sampling results, the potential for quantitative risk associated with these media will be evaluated.

Recreational users would not be exposed to surface or subsurface soils on most of the OU, because they do not have access to the upland areas. Access to most of the upland parcels are restricted by fencing and gates, and so recreational visitors could only access the upland areas of N. Kingsbury Street and portions of the Old Town Village West parcel. The potential risks with upland area to site visitors/trespassers will be addressed qualitatively considering the potential exposure to other receptors that would be expected to have the most exposure to the upland parcels (e.g., commercial/industrial workers or residents). As noted before, all surface and accessible subsurface soil has been removed from the LaSalle-Chestnut parcel and replaced with un-impacted soil; therefore, there is no potential that visitors/trespassers may be exposed to surface or subsurface soil on this parcel.

4.3.4 Residential Land Use Scenario

The North Station OU is located in an area of mixed industrial/commercial and residential property. The Old Town Village West parcel and property located directly to the south and east of the OU is residential. The zoning classifications of most of the property within the OU is not expected to change in the future. This includes the ComEd parcel that contains the substation, and portions of the parcels along the ARA that have overhead transmission lines crossing the property and are currently vacant or used for equipment storage. Residential land use of portions of the LaSalle-Chestnut Parcel have been proposed, but even if the land were developed into residential property, all impacted surface soil and accessible subsurface soil has been removed from these parcels minimizing the potential exposure to MGP-related contaminants.

Soil, groundwater and soil gas data from all portions of the study area except the ComEd parcel will be screened against the residential soil and groundwater SLs presented in the RAF Addendum (Exponent 2011). This screening will include historic data and RI data available for the residential properties on the Old Town Village West and properties adjacent to the site, as well as riverfront parcels (LaSalle-Chestnut and Division-Halsted) due to the potential for residential redevelopment along the ARA. This screening will provide a perspective on any potential health risk associated with residential development of each portion of the study area other than the ComEd parcel. The ComEd parcel will not be evaluated as residential property because the land use of this property is not expected to change in the future from its present use as a substation.

The most likely recreational users of the ARA would be local residents, and so the risks associated with recreational use of the ARA by the local residents (as described previously in section 4.3.3) will be used to put into perspective the risk due to recreational use of the ARA.

Soil, groundwater, and soil gas data collected during the RI will also be evaluated for potential residential future use scenarios. The need for risk management tools, which may include, but are not limited to, institutional controls, will be evaluated in the Feasibility Study (FS) (see Section 8).

4.4 Potential Exposure Pathways – Ecological Receptors

This section evaluates the potential exposure pathways for ecological receptors as presented in the Multi-Site CSM (Integrys 2007a). A site-specific evaluation of the Multi-Site CSM exposure pathways has been considered for the North Station OU. The methods used to evaluate the potential exposures to ecological receptors are discussed in the Multi-Site RAF (Exponent 2007).

The results of the site reconnaissance completed on July 19, 2011 by an Exponent environmental biologist was used throughout this subsection to evaluate which ecological receptors may be exposed to the contaminated media within the North Station OU. As discussed previously in 4.1, there is no ecological habitat in the upland area because of the developed nature of the property. This will be documented in the ecological risk assessment performed for the North Station OU. The ARA provides some limited ecological habitat. A detailed evaluation of the ARA was not performed as part of the habitat assessment, but based on observations made during the site reconnaissance of the ARA from the upland area, and what is known of the River, the ecological receptors to be evaluated further with the baseline ecological risk assessment (BERA) are discussed. During the sediment investigation conducted during the RI, additional observations of ecological receptors will be made, but it is not anticipated to appreciably change the CSM presented herein.

4.4.1 Mammals (Upland and Aquatic)

Carnivorous, piscivorous, insectivorous, omnivorous, and herbivorous mammals are ecological receptors considered in the Multi-Site CSM that may be exposed to COPCs through incidental ingestion of soil, sediment, or surface water and ingestion of plant and prey items. As noted during the site reconnaissance, there is no upland habitat that would support terrestrial mammals. Other than isolated clumps of trees and some scattered weed species of plants along the fence lines, there is no vegetation on the commercial parcels of the site. There are landscaped yards on the residential Old Town Village West parcel, but these are not natural habitats managed to attract mammals. With the exception of landscaped yards on the Old Town Village West parcel, the OU surface is covered with gravel, equipment, and buildings, and because of this, there is no habitat at the OU for terrestrial mammals.

The ARA and adjacent upland area do not appear to provide sufficient habitat for mammals in the aquatic environment. Sheet piling or steep rip rap banks line the ARA within the North Station OU and water depths are reported to be much greater than 2 feet so there are no areas available for wading and foraging by aquatic mammals. Based on site-specific conditions, an assessment of potential risk to terrestrial and aquatic mammals will not be conducted because habitat for mammals does not appear to be present in the North Station OU.

4.4.2 Birds (Upland and Aquatic)

Carnivorous, piscivorous, insectivorous, omnivorous, and sediment probing birds are ecological receptors considered in the Multi-Site CSM that may be exposed to COPCs through either incidental ingestion or dermal exposure of soil, sediment, or surface water or ingestion of plant and prey items.

Terrestrial bird species were not observed within the OU on the day of the site reconnaissance. On the upland portion of the OU, there is limited habitat for birds to nest or forage because the upland area is primarily covered with gravel, buildings, and concrete over the majority of the ground surface. The exception to this are the landscaped yards on the Old Town Village West Parcel, which contain some trees and bushes that could provide nesting habitat for birds. However, these residential properties are not managed as natural areas, and would only provide limited habitat for birds. Terrestrial birds that nest in the yards would likely obtain most of their food from local feeders that the residents place in the yards and so the birds would not be expected to be exposed to MGP related constituents present below the ground surface. Therefore, further ecological evaluation of terrestrial bird species will not be performed as part of the BLRA.

Herring Gulls and Canada geese were observed in the ARA during the site reconnaissance, but other aquatic birds were not observed. Waterfowl species would be expected to use the ARA as a loafing area, but there is limited nesting habitat in the area of the OU.

Sediment probing birds are not expected to be found within or near the ARA because mudflat areas are absent and the water depths are generally reported to be too deep (i.e., 4 to 10 feet) for these types of bird species across the River. Piscivorous and insectivorous birds could be exposed to COPCs through foraging and consumption of affected fish or aquatic insects that are available at the water surface, but the birds would not be exposed directly to sediments. Further, because of the depth of the water in the OU, the availability of fish for consumption by piscivorous birds is expected to be limited. Based on the water depths, lack of mudflat areas, and lack of habitat for aquatic birds in the area of the OU, the potential risk to aquatic birds will be addressed qualitatively in the BERA. As discussed above, there is

limited habitat at the OU for terrestrial bird species, and so they will not be carried forward as an ecological receptor in the BERA.

4.4.3 Fish

Fish are an ecological receptor considered in the Multi-Site CSM that may be exposed to COPCs through incidental ingestion and dermal exposure of sediment and ingestion of food.

As described in Section 6.1.2.1 of the Multi-Site RAF (Exponent 2007), a qualitative biological survey of fish habitat will be performed during the surface water and sediment investigation. The qualitative habitat survey will determine whether fish habitat exists in the investigation area (e.g., spawning grounds or foraging areas). Whether further evaluation of potential risks to fish need to be evaluated in the ecological risk assessment will be determined based on the concentrations of COPCs detected in surface water and sediment, the spatial distribution of COPCs, and the quality of the fish habitat present in the ARA.

4.4.4 Benthic Invertebrates (Aquatic Ecological Receptor)

Benthic invertebrates are considered an ecological receptor that will be exposed to COPCs in sediment and surface water adjacent to the OU. MGP residuals were identified in sediment samples collected in the ARA, but further evaluation of sediment is needed to determine if sediment poses an ecological concern. As discussed in Section 5.4.4 of the Multi-Site RAF (Exponent 2007), benthic invertebrates form the base of many food chains and spend most or all of their lifecycle burrowed or feeding at the interface between surface water and sediment. Potential risks to benthic invertebrates associated with sediment and surface water exposures from the ARA will be evaluated as part of the BERA.

The sediment investigation will be completed in two steps. Step 1 sampling will be to define the general horizontal and vertical extent of MGP-related concentrations of COPC in sediment and compare these investigative sediment concentrations to the concentrations of these COPCs in the ambient study area. Depending up the results of the Step 1 sediment investigation, additional sediment investigation may be completed to better define ecological risk zones by using sediment toxicity testing as a tool. The ability to use sediment toxicity as an effective tool will be evaluated further based on the results of the Step 1 investigation (refer to Section 6.6 and Appendix C).

4.5 Data Needs

As described in the Completion Report (NRT 2011), and previous sections of this SSWP, the media that require further assessment with respect to public health, welfare, or the environment include the following:

- Evaluation of surface or near surface soil on the ComEd and Division parcels is warranted to assess the direct contact exposure pathway. Additional surface soil will be collected concurrent with drilling for well and probe installation on other portions of the study area to confirm the historic data set.

- Direct evaluation of the VI exposure pathway is warranted for Buildings 1 and 2 on the ComEd parcel, where the former MGP facility was located. Additional exterior soil gas probes will be installed to evaluate the potential for VI exposure at Building 5 on the Division parcel and the potential for migration of MGP-residual impacted soil gas off the former facility toward Buildings 6, 7 and 8. After the RI soil, groundwater and soil gas data collection, the need for additional evaluation of the VI exposure pathway will be assessed. Details of the VI evaluation are presented in Appendix E.

- Evaluation of the current extent of groundwater affected by MGP residuals through installation and sampling of nested water table wells and piezometers around the OU perimeter and in impacted areas. Wells will be installed in the fill and underlying clay to:

  - Document flow directions and provide aquifer properties;

  - Assess groundwater quality in the fill and underlying clay units; and

  - Evaluate the interaction of groundwater between the upland OU and the ARA. The monitoring well network should evaluate the magnitude, extent and duration of probable groundwater flow reversals during elevated river stages.

- Evaluation of the extent of soil, groundwater, and soil gas affected by MGP residuals beyond the areas currently identified as such.

- Evaluation of the potential for preferential migration of affected media in utility trenches with high permeability backfill below Hobbie and Kingsbury Streets where MGP residuals have been observed. Exploratory borings or trenching will be conducted in these areas to evaluate the utility trenches as preferential pathways.

- Evaluation of potential for current and historic MGP residual migration from the upland area to the ARA. Though the LaSalle-Chestnut parcel, located at the shoreline, has been remediated and the sewer and discharge pipes from the former MGP facility to the ARA have been abandoned, these features could have been former sources of MGP impacts to the river sediment.

- Evaluate the distribution of COPC in surface water and sediment in the ARA to assess the characteristics of the ARA and the potential risk to human health and the aquatic environment. In addition, sediment will be tested for geotechnical parameters to support a FS.

5 PROJECT SCOPING AND PLANNING ACTIVITIES

As defined in the SOW, the scope of the North Station OU work includes the following tasks:

Task 1: Project Scoping and RI/FS Planning Documents;

Task 2: Community Involvement Support and Technical Assistance Plans;

Task 3: Site Characterization;

Task 4: Remedial Investigation Report (including human health and ecological risk assessments);

Task 5: Treatability Studies (if needed);

Task 6: Development and Screening of Alternatives (Technical Memoranda);

Task 7: Detailed Analysis of Alternatives (FS Report); and

Task 8: Progress Reports.

5.1 Project Scoping (Task 1)

5.1.1 Multi-Site Documents

The Project Scoping and RI/FS Planning Documents, included the creation of multi-site documents that outlined general approaches and concepts with the intent of streamlining preparation of work plans and minimizing review times for future deliverables. In addition, the multi-site documents provide a consistent approach to investigating and assessing former MGP sites for PGL. The multi-site documents that have been prepared to achieve these objectives include the following:

- Multi-Site Health and Safety Plan, Rev 2, August 2007 [(Multi-Site Health and Safety Plan (HASP)];
- Multi-Site Quality Assurance Project Plan, Rev 2, September 2007 (Multi-Site QAPP);
- Multi-Site Conceptual Site Model, Rev 1, August 2007 [(Multi-Site Conceptual Site Model (CSM]);
- Multi-Site Risk Assessment Framework, Rev 0, September 2007 (Multi-Site RAF);
- Multi-Site Field Sampling Plan, Rev 4, September 2008 [(Multi-Site Field Sampling Plan (FSP)]; and
- Multi-Site Feasibility Study Support Documents, April 20, 2010 (Multi-Site FS).

These multi-site documents are intended to set forth the general approaches and concepts for performing RI/FS activities. Site-specific revisions relevant to these multi-site documents are included in Appendix B.

5.1.2 Approach

Previous activities have generated significant quantities of data for characterizing conditions within the OU. The activities proposed in this SSWP will focus on supplementing previously collected data to refine migration and exposure pathways identified through the CSM. Property reconnaissance and sampling activities will be completed to gather data that can be used to support human health risk assessments and FS evaluations.

A dynamic work plan approach has been developed to collect data necessary to satisfy the Data Quality Objectives (DQOs) and address concerns regarding specific pathways. Representatives from USEPA, USEPA's technical support team, PGL, and necessary consultants to PGL will participate in technical meetings to resolve problems.

5.1.3 Project Management Communications

The Site-Specific FSP included in Appendix B3 includes a flow chart of the lines of communication and contact information that will be used during field activities. Additional team members may be added throughout the project duration.

Meetings or teleconferences will be held at least once per week during field activities to provide schedule updates and to discuss problems that may have occurred and resolutions that have been implemented. The frequency of these meetings may be increased depending on the specific activity being performed.

These meetings will include the following personnel:

- USEPA Remedial Project Manager, Mr. Ross del Rosario;
- PGL Project Coordinator, Mr. Naren Prasad, P.E., LEED AP; and
- NRT Project Manager, Ms. Sarah Meyer.

5.1.4 Purpose and Data Quality Objectives Review

DQOs for the North Station OU are consistent with the DQOs presented in the Multi-Site QAPP. As discussed in Section 1, data will be collected during the RI activities to satisfy the following site-specific objectives:

- Evaluate the nature and extent of MGP residuals in surface soil, subsurface soil, groundwater, sediment, surface water, and soil vapor at the North Station OU and assess the characteristics of any residual material, if identified;
- Support development and evaluation of potential remedial alternatives (feasibility studies) if response actions are necessary; and
- Collect data to support a BLRA for human health and evaluate the potential risk for human and ecological receptors.

5.1.5 Preliminary Objectives for Remedial Action

The objectives for remedial action will be developed as part of the FS tasks described in Section 8.1.1. In general, the remedial action objective is to protect public health, welfare, and the environment through risk reduction from MGP impacts.

5.1.6 Preliminary Remedial Action Alternatives

The remedial action alternatives will be developed as part of the FS tasks described in Section 8 and will include site-specific evaluation of Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered requirements.

Remedial action alternatives were previously evaluated before selecting the response actions discussed in Section 2.7. These response actions may be reviewed and updated to reflect current conditions on the OU. In general, responses including, but not limited to, one or more of the following may be appropriate to address MGP residuals:

Soil

- Removal and disposal (previous response action)
- In-situ treatment
- Capping and containment
- Institutional controls

Groundwater

- Containment
- Active remediation (in situ or ex situ)
- Monitored natural attenuation (MNA)
- Institutional controls

Surface Water and Sediment

- Dredge/excavate and disposal
- In-situ treatment
- Capping and containment
- MNA

Soil Vapor

- Engineering or institutional controls
- Soil removal and disposal

5.2 Community Relations (Task 2)

PGL is prepared to provide community relations support if requested by the USEPA. In addition, PGL has and will continue communicating with local residents and authorities regarding the remediation efforts conducted in the Ward. All activities and communications will be coordinated with the USEPA.

6 OU CHARACTERIZATION AND ASSESSMENT ACTIVITIES

The scope of RI characterization and assessment activities addressed by this SSWP includes:

- Mobilization planning
- Site surveying and reconnaissance
- Surface and subsurface soil sampling
- Sediment and surface water sampling
- Groundwater monitoring well installation
- Groundwater sampling
- Soil vapor sampling

Sampling locations, frequencies, analytical parameters, and methods are presented below and specific standard operating procedures (SOPs) are referenced from the USEPA-approved Multi-Site FSP and are included in Appendix F. Work preparation, mobilization, site-specific dynamic sampling and analysis techniques, investigation-derived waste management, record keeping, sample analysis and validation, and data evaluation processes are also discussed. Project files will be managed as described in USEPA-approved SOP SAS-01-02 from the Multi-Site FSP.

Planned field activities will be completed in accordance with the methods and techniques described in the Multi-Site QAPP, Multi-Site RAF, and Multi-Site FSP; these general methods and techniques are not repeated herein. Site-specific information relevant to these multi-site documents are discussed below and details are included in Appendix B. The Site-Specific QAPP and Health and Safety Plan are presented in Appendix B1 and B2, respectively. The Site-Specific HASP is as stringent as or more stringent than the Multi-Site HASP and contains all components of the Multi-Site HASP. The Site-Specific HASP replaces the Multi-Site HASP in its entirety.

The Site-Specific FSP is presented in Appendix B3, and the Site-Specific CSM is included in Appendix B4. Copies of the SOPs referenced herein and the Multi-Site FSP are provided in Appendices F and G, respectively.

6.1 Mobilization Planning

Field mobilization activities will be completed in accordance with USEPA-approved SOP SAS-05-01 and Section 3 of the Multi-Site FSP. These activities include the following:

- Arranging access to all parcels (to be addressed by PGL)
- Notifying and locating utilities through DIGGER – Chicago Digger Hotline, and if necessary, a private utility locating contractor
- Establishing clear communication from the field to office personnel, PGL, and the USEPA/Illinois EPA

Work near buried or overhead utilities will only proceed when utilities and reasonable setbacks can be field-verified and safety standards for operations can be maintained.

6.1.1 Daily Planning

Daily planning will occur as described in the Multi-Site FSP and the Site-Specific HASP including, but not limited to, the following:

- Tracking daily progress
- Identifying and resolving problems
- Communicating with office personnel, PGL, and the USEPA/Illinois EPA, as appropriate, to ensure decision points and objectives for the work are fulfilled
- Holding safety meetings

A field log book will be maintained following the procedure outlined in USEPA-approved SOP SAS-01-01 from the Multi-Site FSP.

6.1.2 Demobilization

Generally, demobilization planning will occur during the pre-mobilization planning as staff and subcontractors plan for the field activities. Issues regarding final status of the property will be identified during the planning process (e.g., ensuring that landscaping issues are addressed).

6.1.3 ComEd Property Access and Safety

All work proposed for the ComEd parcel is contingent on coordination with ComEd. Work will proceed only if it can be performed safely, within ComEd operational requirements, and does not impact service at the substation.

6.2 OU Surveying

Several surveys have been previously completed to identify sampling locations/elevations and notable features. Survey datums used have included North American Datum 1983 (NAD83) Illinois State Plane East coordinates and Chicago City Datum (CCD). A Plat of Survey is available for the ComEd, Halsted and Division-Halsted parcels and is provided in Appendix A5.

Existing survey data will be reviewed to the extent it is available and applicable to establish existing OU conditions. Supplemental survey data will be completed as appropriate in accordance with USEPA-approved SOP SAS-02-02 and Section 7 of the Multi-Site FSP. OU features will be accurately located and survey points will be converted to the USEPA-required Universal Transverse Mercator projection. Features from the individual parcels will be compiled into one comprehensive survey.

Updated survey work and mapping will include the following:

- Establishing a topographic map of the OU;
- Establishing additional location survey information, as appropriate, so that drawings and maps reflect current OU features;
- Establishing new survey control points so future activities and features can be accurately located and tied to a common datum;
- Establishing a staff gage on the ARA to record surface water elevations;
- Surveying the location and elevation of new borings and monitoring wells; and
- Surveying subsurface utility infrastructure on and adjacent to the OU that have the potential to affect migration of MGP residuals.

6.3 Supplemental OU Reconnaissance

Reconnaissance activities have occurred on portions of the OU over the past several years. In accordance with the Multi-Site RAF, additional reconnaissance will be conducted and documented to

support the Site-Specific CSM developed in Section 4 of this SSWP. Reconnaissance will continue at the OU to evaluate pathway completeness for ecological receptors. In conjunction with sediment sampling in the ARA, Habitat Assessment Field Forms will be completed including the Ecological Assessment Checklist for the ARA.

Information was received through a FOIA request to Illinois EPA concerning the voluntary cleanup that was performed at the Old Town Village West (Illinois EPA LPC#: 0316085389) in conjunction with a development project consisting of 130 residential condominium units. The remediation included limited soil removal and installation of engineered barriers (clay cap, concrete barrier/building foundation) which received Illinois EPA NFR letters in 2005. This development occurs over the former PGL property (Old Town Village West parcel) on which there was a building containing a tar vat. According to a notation on a 1910 Sanborn map (Appendix A1), the building was used for "pipe dipping." It appears that the former location of the tar vat is now partially covered by two residential buildings (Appendix K, Attachment K-1). Borings are proposed at the former location of the tar vat building, as described in Section 6.4. In addition, a monitoring well nest is proposed, as described in Section 6.5, immediately downgradient of this former PGL building to assess whether there is evidence of a release of MGP residuals in groundwater warranting further review and/or response actions.

6.4 Surface and Subsurface Soil Exploration and Sampling

6.4.1 Overview

Previous site investigation and response actions are summarized in Sections 2.6 and 2.7, respectively. Additional soil exploration and sampling will evaluate the nature and extent of MGP residuals that remain on portions of the North Station OU. Collected data will be used in a BLRA and FS. The BLRA will evaluate whether the North Station OU presents a risk to human health and the environment.

The proposed sampling locations to complete RI/FS work at the OU are shown on Figure 34. Table 3 presents a list of all borings, probes, monitoring wells, and sampling locations. Table 4 shows a decision tree for selecting soil to be sampled and for boring termination. All sampling locations are pending property access and feasibility. If field conditions restrict placement of a boring in a proposed location, the boring will be executed as close to the proposed location as possible at a position mutually agreed upon by the field team. Special considerations for boring placement may be required on the ComEd parcel and City easements/right-of-ways where infrastructure may limit intrusive activity.

Unless otherwise specified in the following sections, one surface and up to two subsurface soil samples will be collected from proposed soil, well and probe borings (prior to conversion to monitoring wells). Surface soil samples will be collected from 0-6 inches bgs in areas where there is no ground cover (such as pavement or imported clean fill/gravel). At 50% of the surface soil sampling locations, an additional sample will be collected from 6-24 inches bgs. In areas where there is ground cover, true surface samples will not be collected, but near surface samples will be collected at 0-6 inches below the cover layer. Subsurface soil samples will be collected between 2 feet bgs and the termination depth. Soil borings will be advanced to depths of 20 feet bgs or until 4 feet of native clay is encountered which does not exhibit visual, PID or olfactory evidence of impacted conditions, whichever depth is greater. Subsurface soil samples will be selected based on visual observations or elevated PID readings following the sampling decision tree in Table 4, and samples will be classified following USEPA-approved SOP SAS-05-02 from the Multi-Site FSP. If no evidence of impacts is present in a boring, one sample will be collected at the base of the fill unit where, historically, MGP residuals if present have been found on this site.

As noted in Section 6.2, subsurface utility surveying will be conducted for infrastructure that has the potential to affect migration of MGP residuals. Sewer inverts on and adjacent to the OU will be surveyed in the field to verify the size and depth of these structures. This information, along with groundwater elevations, flow orientation, groundwater quality and existing boring logs, will enable the evaluation of whether utility structures intersect groundwater within the clay unit and have the potential to act as preferential migration pathways. If utility infrastructure in Kingsbury, Hobbie or Crosby Streets is confirmed to occur below the water table and within the clay unit, then an approach to evaluating the utility will be applied as described in Section 6.4.5.

6.4.2 ComEd Parcel

Extensive subsurface investigation has been completed in the ComEd parcel. Supplemental investigations will focus on the surface soil and soil vapor exposure pathways as well as migration of MGP residuals via groundwater.

Surface soil samples (NOS-SS104 through 113) will be collected at ten unpaved locations across the parcel to evaluate potential direct contact exposure pathway, as shown on Figure 34. If present, samples will be collected below any gravel or cover layer that may be present at the surface. Soil sampling details can be found on Tables 2 and 3.

6.4.3 Division Parcel

Soil and groundwater investigations have not been previously conducted on the Division parcel. MGP residuals have been observed in soil near the common property boundary between this parcel and the ComEd parcel. Borings will be advanced and wells installed on the Division parcel to delineate the extent of impacts north of the former MGP facility.

Three soil borings (NOS-SB101 through 103) are proposed for this parcel to further evaluate the northwestern extent of MGP residuals in soil (Figure 34). Two soil borings will be located adjacent to the ComEd property boundary and one boring on the north end of Kingsbury Street. In addition, borings will be advanced to install a monitoring well nest (NOW-MWW/P101) and water table well (NOW-MWW102) on the parcel, along with additional borings adjacent to Building 5 for installation of soil gas probes (NOWA-SG5 to 8). These borings will be logged and sampled prior to installation of the wells and probes.

Subsurface soil samples will be collected from the soil, well and probe borings (prior to conversion to monitoring wells or soil gas probes) per Section 6.4.1. Logging and sampling of soil encountered during installation of wells and soil gas probes are discussed in more detail in Sections 6.5 and 6.7. Soil sampling details can be found on Tables 2 and 3.

6.4.4 Old Town Village West Parcel

Soil and groundwater investigations have been previously conducted on the Old Town Village West parcel in conjunction with UST removals, property transfers and redevelopment. Non-MGP residuals have been observed in soil near several of the former USTs. Two soil borings (NOS-SB104 and 105) will be performed on this parcel to evaluate the presence/absence of MGP residuals below and adjacent to the former PGL building which contained a tar vat (Figure 34). The material comprising the former floor of this building is unknown. As field conditions allow, one soil boring will be located adjacent to the north end of the former building floor and one boring directly below the former tar vat location.

No surface soil samples will be collected at these locations because the upper 1.5 feet of soil has a compacted clay and topsoil barrier in place intended to minimize potential for direct contact exposure. Therefore, a sample will be collected in the fill directly below the surface compacted clay cover layer at 1.5 to 2.0 feet bgs. Up to two soil samples may be collected below 2.5 feet bgs if visual/olfactory evidence of petroleum and/or MGP residuals are observed. If no visual/olfactory evidence is observed, a

soil sample will be collected in the fill at the fill/clay unit interface. Soil sampling details can be found on Tables 2 and 3.

In addition, borings will be advanced to install subslab sampling probes (NOS-SG17 and NOS-SG18) on the parcel inside two residences of Building Group 6. These borings will be logged and sampled prior to installation of the probes.

Subsurface soil samples will be collected from the soil and probe borings (prior to conversion to subslab soil gas probes) per Section 6.4.1. Logging and sampling of soil encountered during installation of subslab soil gas probes are discussed in more detail in Sections 6.7. Soil sampling details can be found on Tables 2 and 3.

6.4.5 Kingsbury Street

More detailed subsurface assessments will be conducted on each end on Kingsbury Street (NOS-AREA-101 and NOS-AREA-102) to evaluate the extent, if any, that backfill within infrastructure trenches may be acting as preferential migration pathways for groundwater containing MGP constituents. The areas of these assessments are shown on Figure 34, approximate locations of reported utilities in the area are shown on Figure 25. These assessments will proceed, pending confirmation of further information, including the following:

- A private utility survey confirming field locations of known or suspected buried infrastructure, based on information obtained from the City of Chicago Office of Underground Coordination.
- Field surveys locating features such as sewer manholes and pipe invert elevations that supplement existing property survey data, reports, as-builts and other information sources.

If utility infrastructure is confirmed to occur below the water table and within the clay unit, a monitoring program will be developed to assess whether the utilities are preferential migration pathways for MGP residuals. As appropriate, the monitoring may consist of field screening and/or sampling backfill in test pits, soil borings and/or contingency wells installed in the utility corridors to evaluate and monitor seepage of groundwater into the utility bedding as a preferential pathway. The need for this monitoring will be evaluated once groundwater elevations in the area are verified and infrastructure as-built construction is reviewed.

6.4.6 Sampling Methods and Abandonment

Drilling methods and procedures are described in the Multi-Site QAPP and Multi-Site FSP. Proposed subsurface soil samples will be collected via hollow-stem auger (HSA) borings or direct-push methods. Soil samples will also be collected as part of a groundwater monitoring well installation or soil vapor sampling, if warranted by field conditions, which are discussed in more detail in Sections 6.5 and 6.7. Sample locations will be identified and recorded in accordance with USEPA-approved SOP SAS-03-03 from the Multi-Site FSP.

Test pits may be excavated or exploratory borings installed to depths necessary to expose utility infrastructure backfill. Soil and/or groundwater grab samples will be collected if there is visual, PID or olfactory evidence of impacted conditions. The test pits or exploratory borings, if performed, will be in accordance with USEPA-approved SOPs SAS-05-06 and SAS-05-07 from the Multi-Site FSP.

Field equipment will be calibrated prior to use as required by USEPA-approved SOP SAS-02-01 from the Multi-Site FSP. During drilling, soil borings will be continuously field-screened to document subsurface conditions and identify samples for laboratory analysis according to USEPA-approved SOP SAS-06-01 from the Multi-Site FSP. Field screening will occur in accordance with the methods and screening techniques identified in the Multi-Site FSP. Borehole logging guidance developed specifically for MGP investigations will be used to assist the field team in describing tar in borings and is included in Appendix J. Observations or field-screening results suggesting that the soil is impacted by a potentially unrelated source will be noted on the drilling logs.

Grab samples will be collected for VOC analysis using Encore samplers at the depth interval exhibiting the highest PID reading or as otherwise documented in the field. QC samples will be collected with the frequency described in Table 2 and required by USEPA-approved SOP SAS-04-03 from the Multi-Site FSP.

Samples will be labeled and packaged in accordance with USEPA-approved SOP SAS-03-01 from the Multi-Site FSP and shipped via overnight courier using chain-of-custody procedures described in USEPA-approved SOP SAS-03-02 from the Multi-Site FSP. Equipment will be decontaminated after use in accordance with USEPA-approved SOP SAS-04-04 from the Multi-Site FSP.

If soil borings are advanced to install a well and the borehole has to be offset due to refusal, or if for any reason the boring is not converted to a well, the original soil boring will be abandoned in accordance with the methods described in USEPA-approved SOP SAS-05-05 and Section 4 of the Multi-Site FSP. Then the new offset boring will again be advanced.

6.5 Groundwater Evaluation

As previously discussed, existing data indicates groundwater flows in a westerly to southwesterly orientation toward the North Branch Canal of the Chicago River. Groundwater sampling (water table wells and piezometers) is proposed at 16 locations and one sump, as shown on Figure 34, to address specific areas of the site. The proposed monitoring well network will evaluate the hydrogeology of the perched groundwater above the native clay with water table wells. Piezometers will be installed in the clay unit to aid in assessing the depth of MGP residual migration as well as deeper groundwater flow orientation. The monitoring well network strategy is as follows:

- Five wells will be installed upgradient of the OU east of Crosby Street to establish background conditions.
  - One water table well (NOS-MWW-104) will be installed at the former location of MW-4 where free product was reportedly observed in a previous site investigation.
  - One monitoring well nest (water table well NOS-MWW-103 and piezometer NOS-MWP-103) will be installed upgradient of the ComEd parcel near the north end of Crosby Street.
  - One monitoring well nest (NOS-MWW-105 and NOS-MWP-105) will be installed upgradient of the ComEd parcel near the south end of Crosby Street. This well nest is also located downgradient of the Old Town Village West parcel adjacent to the former location of two USTs and downgradient of a former PGL building which contained a tar vat.
- One water table well (NOS-MWW-116) will be installed on the ComEd parcel at the intersection of Elm Street and Crosby Street. This well is on the upgradient side of the ComEd parcel and downgradient of the former location of MW-4 where free product was reportedly observed.
- One water table well (NOS-MWW-102) will be installed at the intersection of the ComEd and Division parcels at Division Street to confirm the northern extent of MGP constituents in groundwater. This location is side-gradient to the OU and will also be utilized to assess groundwater flow orientation.
- One well nest (NOS-MWW-101 and NOS-MWP-101) will be installed adjacent to the existing Building 5, a commercial building on the Division parcel, to confirm the northern extent of MGP constituents in groundwater. This location is side-gradient to the OU and will also be utilized to assess groundwater flow orientation.
- Two monitoring well nests will be installed adjacent to and south of Hobbie Street on the City ROW. These locations are side-gradient to the OU and will also be utilized to assess groundwater flow orientation.
  - One monitoring well nest (NOS-MWW-106 and NOS-MWP-106) will be installed to confirm the southern extent of MGP constituents in groundwater.

- One monitoring well nest (NOS-MWW-107 and NOS-MWP-107) will be installed to confirm the southern extent of MGP constituents in groundwater and monitor possible preferential migration of MGP residuals along the buried utility corridors along Kingsbury Street.

- Two well nests will be installed directly downgradient of the former MGP along Kingsbury Street where NAPL was detected in previous borings. These well nests are proposed on the City ROW along buried infrastructure (as discussed in Section 6.4.4) adjacent to and upgradient of the Halsted parcel.

  - One monitoring well nest (NOS-MWW-114 and NOS-MWP-114) will be installed to assess groundwater flow orientation and groundwater quality downgradient of the north side of the former MGP operations.

  - One well nest (NOS-MWW-115 and NOS-MWP-115) is proposed to assess groundwater flow orientation and groundwater quality downgradient of the south side of the former MGP operations. This well nest location is also upgradient of the slurry containment wall installed along Kingsbury Street between the former MGP operations and excavated areas on the LaSalle-Chestnut parcel.

- Two well nests (NOS-MWW-112, NOS-MWP-112 and NOS-MWW-113, NOS-MWP-113) will be installed downgradient of the former MGP on the Halsted parcel to assess groundwater flow orientation and whether MGP residuals are migrating onto the property. These well nests will be installed on the downgradient side of the Kingsbury Street utilities and will also be used to monitor the potential for diversion of flow down the utility corridors.

- Four additional well nests are proposed on the LaSalle-Chestnut parcel.

  - One monitoring well nest (NOS-MWW-108 and NOS-MWP-108) will be installed to assess groundwater flow orientation and groundwater quality on the downgradient side of the slurry containment wall installed along Kingsbury Street between the former MGP operations and excavated areas on the LaSalle-Chestnut parcel.

  - One well nest (NOS-MWW-110 and NOS-MWP-110) will be placed in the backfill within the deepest area of excavation on the LaSalle-Chestnut parcel. This well nest will assess possible changes in OU hydrogeology resulting from the depth of remediation and backfill.

  - The remaining two well nests (NOS-MWW-109, NOS-MWP-109 and NOS-MWW-111, NOS-MWP-111) will be placed near the shoreline to assess groundwater flow orientation, groundwater/river interaction and the potential for MGP residuals to discharge into the ARA.

- One basement sump (NOS-SU1) in Building 1 on the ComEd parcel will be sampled to assess groundwater quality and potential VI underneath the building.

All groundwater sampling is subject to obtaining property access and the feasibility of well installation.

6.5.1 Monitoring Well Installation

Water table wells are expected to be installed to depths of less than ten feet and will terminate within the fill unit in order to assess the presence of and flow orientation of perched groundwater. Water table well screens will be set at the top of the native clay unit with a maximum screen length of ten feet. If the fill thickness is less than 13 feet, the well screen length will be decreased so that there is at least three feet of casing below the ground surface to provide an effective surface seal.

Piezometers will be installed to a target depth of approximately 15 feet below the top of the clay unit to enable a sealed interval of at least 5 feet between the base of the fill unit and the top of the piezometer screen. The wells will be installed in accordance with USEPA-approved SOP SAS-05-03 from the Multi-Site FSP and will be constructed of polyvinyl chloride with a 10-foot screen length. At monitoring well locations where MGP residuals are encountered at the clay/fill unit interface, drilling procedures will be implemented that will minimize the potential for cross-contamination of piezometer installations. Those procedures may include installation of additional well casing to isolate impacted zones from piezometer screen depths and/or other appropriate measures dictated by the conditions encountered.

As described in Section 6.4.1, soil borings, whether they are for soil investigation, monitoring well or soil gas probe installation, will be advanced to depths of 20 feet bgs or until 4 feet of native clay is encountered which does not exhibit visual, PID or olfactory evidence of impacted conditions, whichever depth is greater. In the event that considerable impacts by MGP residuals are observed in a boring within 2 feet of bedrock, installation of a bedrock well at or near that location will be considered. The bedrock well would be used to monitor the potential for deeper migration of MGP residuals. Bedrock well installation will be performed is accordance with USEPA-approved SOP SAS-05-03 from the Multi-Site FSP.

Soil samples will be collected during well installation as described in Section 6.4.1.

Historically, insufficient or no groundwater has been encountered in this area when trying to install, develop, and sample monitoring wells. Therefore, it is unknown if all 16 locations will be suitable for well installation and/or sampling. If insufficient water becomes an issue, USEPA approval for a reduced number of wells will be requested during the field activities.

6.5.2 Groundwater Monitoring Well Development

The installed monitoring wells will be developed following installation in accordance with the bailing and pumping methods described in USEPA-approved SOP SAS-05-04 and Section 4 of the Multi-Site FSP. Monitoring well development will continue until field parameters stabilize and at least five well volumes of water have been removed in accordance with USEPA-approved SOP SAS-08-03 from the Multi-Site FSP. If liquids are introduced into the borehole during drilling or well construction activities, an additional volume of water equal to three times the amount added will be removed from the well. Purge water from well development activities is anticipated to be sampled and disposed of at a permitted off-site treatment facility. Approval will include any necessary compliance with the Off-Site Rule (OSR), 40 CFR 300.440.

6.5.3 Groundwater Sampling

Low-flow groundwater sampling will be completed for all wells using a peristaltic pump as described in USEPA-approved SOP SAS-08-02 and Section 4 of the Multi-Site FSP, provided the depth to water after sampling does not exceed 15 feet. If water depths exceed 15 feet after sampling, regardless of stability, subsequent low-flow sampling events will be conducted using a bladder pump. In the event that a well does not produce sufficient water for using these methods (i.e., water column less than 2 feet or very low recharge rates), the well will be purged dry, allowed to recharge, and sampled with a bailer within approximately 24 hours of purging.

If water is present in the sump, it will be sampled without purging using a bailer or peristaltic pump. The peristaltic pump can be used provided the depth to water after sampling does not exceed 15 feet. Field parameters will be measured as described in USEPA-approved SOP SAS-08-02.

USEPA sample identification protocol and sampling forms will be used to ensure that samples are tracked accordingly and that the laboratory analytical data are provided in a manner consistent with the USEPA database requirements. Field parameters will also be recorded during well purging including pH, temperature, turbidity, dissolved oxygen, oxidation/reduction potential, and conductivity.

Surface water samples will be collected at two shoreline locations concurrent with the spring and summer quarter groundwater sampling events. Details of the surface water sampling are provided in Section 6.6.3.

6.5.4 Groundwater Level Measurements

Groundwater elevations will be documented to assess the direction of groundwater flow whenever the monitoring wells are sampled or as needed to assess flow conditions. Water level measurements will be collected from all monitoring wells regardless of whether the particular location is being sampled. Thickness of NAPL, if present, will be measured concurrent to gauging of the monitoring wells. The measurements will be completed within the first twelve hours of a sampling event in accordance with the methods described in USEPA-approved SOP SAS-08-01 and Section 4 of the Multi-Site FSP. Observations regarding the presence of MGP residuals within a well will be recorded on the same forms as the water level measurements.

Installation of a staff gauge in the ARA, or surveying the river surface elevation and measurement of surface water levels, will be conducted concurrent to measuring groundwater elevations within monitoring wells to evaluate surface water/groundwater relationships.

6.5.5 Sampling Schedule and Parameters

Groundwater monitoring will be initiated on a quarterly basis for four sampling events following the well installation. The proposed sampling locations are presented on Figure 34. The monitoring schedule will be continuously reviewed and updated, as appropriate.

The sump will not be sampled quarterly. Instead, it will be sampled concurrent with vapor sampling inside Building 1. It is expected that the sump water will be sampled twice.

Continued groundwater sampling will be completed for the following reasons:

- To detect changes in environmental conditions (e.g., hydrogeologic or chemical) that may result in an increased risk or exposure potential;
- To identify potentially toxic or mobile transformation products;
- To assess plume stability and groundwater concentration trends;
- To assess the need to revise the COPC list; and
- To detect new releases of constituents to the environment that could affect potential remedial action alternatives (e.g., MNA or institutional controls).

Prior to sampling, wells will be inspected and evaluated following USEPA-approved SOP SAS-08-05 from the Multi-Site FSP. The Well Condition Field Form, contained in the Multi-Site FSP, will be completed any

time a well is sampled or the water elevation is measured as part of continued groundwater monitoring. In addition, the field measurements of total well depth will be compared to the monitoring well logs annually to detect potential issues with a well.

The RI Report will be prepared after two quarterly rounds of groundwater data are collected from the yielding wells with supplemental data added later. The estimated project schedule for the well installations and quarterly sampling is shown on Figure 36. Groundwater samples will be collected and analyzed for the parameters listed on Table 2 following the corresponding analytical methods, until/unless the COPC list is revised, based on continuing evaluation of previous sampling results. COPCs may be dropped from the list of analytical parameters for a well after they appear in concentrations less than residential SLs for two consecutive sampling events. Samples will be analyzed in a fixed-base laboratory as described in the Multi-Site QAPP and the Multi-Site FSP.

6.5.6 Aquifer Characterization

Single well aquifer tests in the form of slug tests will be conducted to characterize hydraulic conductivity in accordance with the methods described in USEPA-approved SOP SAS-08-04 and Section 4 of the Multi-Site FSP. Aquifer tests will be performed in all piezometers installed within the clay unit. Six wells within the surficial fill unit will be selected for slug testing.

6.5.7 Groundwater Monitoring Well Abandonment

If any of the wells in the monitoring network require abandonment, these activities will be completed in accordance with the methods described in USEPA-approved SOP SAS-05-05 and Section 4 of the Multi-Site FSP. No well abandonment activities are currently planned.

6.5.8 On-Going Groundwater Monitoring

The need for continuing or revising groundwater monitoring activities will be evaluated with the USEPA after completing the fourth quarter of groundwater sampling. The RI Report will provide a plan for continued groundwater monitoring between the timeframe of the RI report issuance and implementation of remedial action. Post-RI report activities include continued monitoring, reporting, and evaluating trends in groundwater quality.

In addition, the groundwater COPC list will be re-evaluated after the first and second rounds of sampling. Modification of the COPC list may be warranted based on results of initial soil and groundwater sampling. See further discussion concerning the COPC list in Appendix D.

6.6 North Branch Canal of the Chicago River

This section discusses sediment and surface water sampling activities that will be completed within the River adjacent to the upland portion of the North Station OU. Sediment and surface water sampling locations in the ARA are shown on Figure 35.

6.6.1 Assessment Objectives

ARA investigation activities will be conducted in two steps to first characterize existing conditions and then refine areas of concern for use in the FS. Step I objectives include the following:

- To establish a statistically sound assessment of ambient conditions not influenced by MGP residuals through an evaluation of upstream sediment quality and toxicity;
- To determine the river bathymetry;
- To determine sediment thicknesses;
- To establish a statistically sound assessment of the overall area, characterize the presence of MGP residuals and, if necessary, evaluate toxicity adjacent to and downstream of the North Station OU;
- To determine the nature and extent of MGP-derived impacts to surface water and sediment;
- To use forensic chemistry methods on sediment samples to assess the source and origin of PAHs in the sediment profile; and
- To determine the relationship and interaction of surface water and groundwater.

Step II will be implemented to focus on defining the incremental PAH contributions from MGP residuals at the OU as well as further delineating MGP residuals. Since results of the toxicity testing conducted during the North Branch of the Chicago River ambient sediment study in March 2011 indicate that the sediment in the ambient region of the River should be able to support benthic invertebrates, toxicity testing may be used to determine site-specific risk at the ARA. Results from the ambient sediment study and the Step I sampling in the ARA will be considered prior to designing the Step II sampling plan. Following sampling in the ARA, risk zones within the ARA will be delineated for use in identifying future remedial alternatives.

6.6.2 Site Morphology

The River has a generally northwest-southeast orientation and water flows to the southeast. A USGS stream gauging station (#05536105) is located on the River at Albany Avenue in West River Park. This gauging station is located upstream of the River's confluence with the North Shore Channel approximately five miles upstream of the North Station OU. Stream gauging data are available for this location; however, the distance from the OU and input from the North Shore Channel and other sewer outfalls likely limit the value of the information with respect to flow past the OU. As an alternative, estimates of storm flow input will be requested from the Metropolitan Water Reclamation District of Greater Chicago to evaluate potential peak flow through the River during storm events, which may be of use during the FS.

Water level fluctuations in the River will be monitored with a pressure transducer and datalogger affixed to a staff gage installed on one of the seawalls, bollards, or bridge abutments in the area. Water level elevations from the River will be recorded every 15 minutes to assess daily variability and responses to precipitation events over approximately three months. Water level elevations from the River will also be measured manually at the staff gage concurrent with measurement of groundwater elevations. Collected data will be used during the FS evaluations to assess flow in the River.

6.6.3 Surface Water Sampling

One surface water sampling event will be conducted to characterize surface water quality at and upstream of the ARA. Two additional surface water sampling events will be conducted at limited sampling locations during the spring (high flow) and summer (low flow) groundwater sampling events. The first sampling event will be full-scale sampling (8 sampling locations) conducted prior to or during sediment sampling (Figure 35). A second full-scale surface water sampling event may be added if a benthic community assessment is performed. Full-scale surface water sampling will be targeted for warm-weather months when more volatile and semi-volatile compounds would be expected in the water column. If possible, full-scale surface water sampling will coincide with groundwater sampling events.

For the full-scale surface water sampling, four surface water samples will be collected from the same ambient sampling locations selected for the Division Street OU, and four samples will be collected from proposed sediment sample locations in the North Station OU (Figure 35). These data will be used to evaluate potential differences in water quality between ambient conditions and locations directly adjacent to the OU. The four surface water sample locations that correspond to proposed sediment sampling

locations were selected to assess water quality at the North Station OU for use in future evaluations of remedial alternatives. The full scale surface water sampling locations are provided below:

Full-Scale Surface Water Sample Location Coordinates

Site Sample Locations			Ambient Sample Locations		
Location ID	**Easting (X)**	**Northing (Y)**	**Location ID**	**Easting (X)**	**Northing (Y)**
SWS-4NOS	1,171,313	1,906,979	SWA-1NOS	1,168,097	1,911,946
SWS-10NOS	1,171,139	1,907,280	SWA-2NOS	1,166,728	1,912,584
SWS-13NOS	1,170,965	1,907,372	SWA-3NOS	1,165,790	1,914,180
SWS-20NOS	1,170,858	1,907,605	SWA-4NOS	1,163,484	1,915,840

Coordinate System is Illinois State Plane East, NAD83 (feet)

Two smaller scale surface water sampling events will be conducted during the spring (high flow) and summer (low flow) groundwater sampling events. During each sampling event, two surface water samples will be collected at the shoreline within the ARA. The exact locations of the samples will be determined by the field team and will consider shoreline access issues while targeting the areas downgradient of the current and former outfall structures along the ARA. The location of the samples will be documented at the time of sample collection.

Sample results for surface water will be compared to SLs to evaluate the need for additional samples. Surface water sampling will not be conducted following a precipitation event that exceeds 0.5 inches until the River returns to normal flow conditions based on water level monitoring.

Surface water samples will be collected from each location at 0.8 times the total water column depth and submitted for laboratory analysis of COPCs (Tables 1 and 2). Surface water samples will be labeled in accordance with USEPA-approved SOP SAS-03-01 from the Multi-Site FSP.

Surface water samples will be collected using a peristaltic pump with the tubing attached to a pole in accordance with USEPA-approved SOP SAS-09-01 and Section 4 of the Multi-Site FSP. Field characteristics will be monitored during sampling using a flow-through cell to evaluate pH, temperature, dissolved oxygen, oxidation/reduction potential, conductivity, and turbidity. Surface water samples will be analyzed for the COPCs listed in Table 1 in accordance with the Multi-Site QAPP.

At each full-scale surface water sampling location, the water velocity will be recorded for use in the FS to evaluate sediment stability. Water velocity will be measured in accordance with USEPA-approved SOP SAS-09-02 and Section 4 of the Multi-Site FSP.

Actual sampling locations will be recorded using a handheld differential global positioning system (DGPS) with sub-meter accuracy in accordance with the methods described in USEPA-approved SOP SAS-03-03 and Section 7 of the Multi-Site FSP.

6.6.4 Bathymetric Survey

River bathymetry will be evaluated using either single-beam or multi-beam sonar, based on contractor availability and costs. The bathymetric survey will provide a comprehensive assessment of the river geometry and water depths covering the width of the River over a total distance of approximately 1,800 feet from the Division Street bridge to a point approximately 200 feet downstream of the south edge of the sediment sampling area in the ARA. The survey will be completed by running six longitudinal transects and 19 transverse transects (spaced approximately 100 feet apart). Additional bathymetric transects may be added in the field at the direction and discretion of the RI Study Leader.

The bathymetric survey will be completed by an outside subcontractor who will be identified to the USEPA prior to initiating the field activities. The subcontractor's SOPs will be provided to the USEPA for review and approval. The survey will be presented in the RI Report and will be used to establish baseline conditions, estimate River hydrologic characteristics, and provide information for use in the FS.

6.6.5 Sediment Thickness Assessment

The objective of the sediment thickness assessment is to identify locations of sediment accumulation within the ARA and to assess areas warranting additional evaluation. The presence and physical characteristics of soft sediment and the relative sediment thickness adjacent to the OU will be assessed through the collection of hand push-cores. Physical characteristics will be evaluated such as sediment particle size, the presence of sediment layers, and the consistency of sediment thickness throughout the investigation area. This work will be completed using push-core sampling methods because remote sensing and geophysical techniques have proven to be insufficient in the River due to sediment thicknesses greater than 10 feet and the presence of biogenic gas, debris, and shallow water depths.

The sediment thickness assessment will be conducted as follows:

- The water depth will be measured using a 2-inch diameter aluminum pole marked in 1-foot increments and 1-inch subdivisions.
- A 5-foot long clear PVC sample tube will be attached to a push-core sampler with a check valve, which will be lowered to the top of sediment based on the measured water depth.

- The hand core will be pushed into the sediment for a depth up to 5 ft. The aluminum pole may be used as a guide for the total distance pushed. The sampler should not be pushed more than 5 feet into the bottom material, otherwise the check valve may not adequately seal the tube and the sample will be invalid.
- The total depth that the core was pushed will be recorded on the field sheets.
- The total length of recovered material and the thickness of the silt layer and any other material in the sample will be measured, recorded on field sheets, and photographed.
- The check valve will be released to allow the sediment to exit the sampling tube.
- The recovered sediment will be containerized for off-site disposal as investigative waste following completion of the other RI sediment sampling activities.

These sediment cores will be collected from 15 paired locations listed in the table below and shown on Figure 35. These locations were developed as part of the statistically generated random sampling pattern. These sampling locations are the same as those proposed for the Step I sediment sampling. Further details on the sampling design are provided in Section 6.6.6.1. For purposes of the sediment thickness assessment, these locations will provide distribution information for the presence or absence of fine- and coarse-grained materials within the ARA.

Sediment Thickness Core Sample Location Coordinates

Location ID	Easting (X)	Northing (Y)	Location ID	Easting (X)	Northing (Y)
PCA-1NOS	1,171,279	1,906,893	PCA-16NOS	1,170,933	1,907,505
PCA-2NOS	1,171,333	1,906,913	PCA-17NOS	1,170,857	1,907,507
PCA-3NOS	1,171,301	1,906,928	PCA-18NOS	1,170,882	1,907,558
PCA-4NOS	1,171,313	1,906,979	PCA-19NOS	1,170,774	1,907,594
PCA-5NOS	1,171,201	1,907,066	PCA-20NOS	1,170,858	1,907,605
PCA-6NOS	1,171,261	1,907,100	PCA-21NOS	1,170,769	1,907,666
PCA-7NOS	1,171,191	1,907,114	PCA-22NOS	1,170,752	1,907,702
PCA-8NOS	1,171,241	1,907,127	PCA-23NOS	1,170,670	1,907,766
PCA-9NOS	1,171,110	1,907,185	PCA-24NOS	1,170,656	1,907,806
PCA-10NOS	1,171,139	1,907,280	PCA-25NOS	1,170,569	1,907,828
PCA-11NOS	1,171,038	1,907,284	PCA-26NOS	1,170,668	1,907,875
PCA-12NOS	1,171,080	1,907,297	PCA-27NOS	1,170,558	1,907,891
PCA-13NOS	1,170,965	1,907,372	PCA-28NOS	1,170,608	1,907,930
PCA-14NOS	1,171,001	1,907,449	PCA-29NOS	1,170,486	1,908,042
PCA-15NOS	1,170,928	1,907,490	PCA-30NOS	1,170,559	1,908,030

Coordinate System is Illinois State Plane East, NAD83 (feet)

Samples will be labeled as PCA-1NOS through PCA-33NOS. These samples will be labeled as "PCA" (Physical Characterization Assessment) to differentiate these locations from samples collected for COPC analysis (Section 6.6.6). Samples PCA-1NOS through PCA-30NOS will be collected. Sampling locations will be recorded using a DGPS unit with sub-foot accuracy in accordance with the methods described in USEPA-approved SOP SAS-03-03 and Section 7 of the Multi-Site FSP.

The presence of marker buoys in the River downstream of the south edge of the OU indicates that there may be an obstruction located in the channel. Local lore indicates that the buoys may be marking a shipwreck. Remnants of a vessel known as the Showboat Sari II, or Sari-S, may be present on the river bottom at this location and sampling locations may need to be offset slightly based on field conditions.

6.6.6 Step I Sediment Sampling Activities

As discussed in Section 6.6.1, a two-step sediment sampling approach has been developed. Step I sampling will provide an indication of the distribution of MGP residuals and determine exposure risk concentrations through a comparison to background contaminant concentrations or a site-specific risk assessment based on toxicity sampling results. Step II sampling will further delineate the extent of MGP residuals relative to the background or developed risk numbers. Using the two-step process, the extent of MGP residuals will be determined for use in the FS and remedial alternatives analysis.

6.6.6.1 Step I Sampling Rationale

MGP residuals have been identified in the river portion of the North Station OU (B&McD, July 2006). Based on these findings, sediment sampling is proposed and will consist of two steps. The Step I sediment sampling program has been developed to provide a statistically valid analysis of sample data because PAHs are often ubiquitous in an urban settings. While MGP residuals are known to be present in near-shore areas, their distribution farther into the River and downstream needs to be assessed. Therefore, sediment sampling has the following two objectives:

- Characterize the spatial (vertical and horizontal) distribution of COPCs in sediments within, near, and downstream of the North Station OU, and statistically evaluate and compare with ambient concentrations to support future remedial alternative decisions.
- Provide data to support human and ecological risk evaluations for COPC concentrations in river sediments. Sampling design is preferentially weighted toward surface samples because surface sediment is expected to be the primary driver for risk evaluations. Surface sediment samples will be analyzed from all locations, while deeper samples from only half of all cores will be analyzed initially.

Step I sampling will also be completed to obtain representative sediment samples for geotechnical and waste disposal characterization.

The Step I sediment sampling design is based on a statistically generated random sampling pattern developed using ESRI ArcGIS. Using the random sampling pattern provides for the collection of sediment samples from spatially unbiased sampling points. The ARA is divided into 15 segments/transects, and two samples will be collected from each segment/transect to evaluate COPC concentrations on each half (east and west portion) of the ARA. The same sampling locations will be used for Step I sampling as will be used for the sediment thickness assessment. Sediment cores will be collected at all of the sampling locations, and the initial focus will be on surface samples for evaluation of current exposure conditions.

Analytical data will be used to evaluate the range of COPC concentrations in surface and subsurface sediments adjacent to and downstream of the OU. Additionally, data will be used, as described in Appendix C, to identify sediment zones above ambient COPC concentrations using specific statistical methods. Surface sediment concentrations will also be used to evaluate risk to human and ecological receptors in the BLRA as specified in the Multi-Site CSM and according to the methods in the Multi-Site RAF. Sampling will begin at the downstream end of the grid and proceed upstream to limit the effects of the sampling activities on surface sediments in areas remaining to be sampled.

Additional Step I downstream samples may be collected following collection of the first 33 samples if results indicate the extent of MGP residuals has not been laterally characterized in the downstream direction. These additional samples will be collected from random locations using the previously outlined approach. The decision to collect additional samples downstream of the OU will be based on field observations, and if available, laboratory analytical results from samples collected earlier in the sampling event. This dynamic approach to delineating sediment with residual concentrations above ambient concentrations or SLs is presented in Section 7 of the Multi-Site RAF.

Since results of the toxicity testing conducted during the North Branch of the Chicago River ambient sediment study in March 2011 indicate that the sediment in the ambient region of the River should be able to support benthic invertebrates, toxicity testing may be used to determine site-specific risk at the ARA. Results from the ambient sediment study and the Step I sampling in the ARA will be considered prior to designing the Step II sampling plan. Step II sampling may be implemented to calculate a site-specific risk value based on ecological receptors. Step II sampling will also identify risk zones based on COPC concentrations in sediment and the nature of sediments with COPCs that exceed the calculated site-specific risk value. The sampling events may employ different sampling techniques and may have a

refined COPC list based on the Step I analytical results. The Step II sampling event will be described in a subsequent submittal.

6.6.6.2 Ambient Sediment Sampling Summary

Due to the location of the former MGP within an urban setting and historic releases to the River from a variety of industrial sources, a separate program for sampling ambient sediment was developed during preparation of the Division Street OU SSWP (Appendix C). The ambient sediment sampling locations (Figure 37) that were sampled within the North Branch of the Chicago River during the March 2011 investigation will be used as the ambient sediment data for this investigation.

6.6.6.3 Step I Sediment Sampling and Analysis

Sediment cores will be collected from 33 proposed locations (Figure 35). Samples of the upper 6 inches of sediment will be collected and analyzed for COPCs at every location. Only selected subsurface intervals will be submitted for analysis of COPCs (rather than the entire core), based on field observations. This is discussed in more detail below.

Based on previous sediment sampling results along the River, cores may need to extend to depths of at least 8 feet below the top of sediment to assess current conditions.

The same sampling locations will be used for Step I sampling as will be used for the sediment thickness assessment (Section 6.6.5) (Figure 35). The random sampling pattern described in Section 6.6.6.1 provides for the collection of sediment samples from spatially unbiased sampling points. An additional three biased sampling locations were selected for Step I sampling near the shoreline adjacent to the upland Halsted, Division-Halsted and LaSalle-Chestnut parcels where current and former discharge sewers and pipes were located. Step I sampling locations are presented below:

Step I Sediment Sampling Location Coordinates

Location ID	Easting (X)	Northing (Y)	Location ID	Easting (X)	Northing (Y)
CCA-1NOS	1,171,279	1,906,893	CCA-18NOS	1,170,882	1,907,558
CCA-2NOS	1,171,333	1,906,913	CCA-19NOS	1,170,774	1,907,594
CCA-3NOS	1,171,301	1,906,928	CCA-20NOS	1,170,858	1,907,605
CCA-4NOS	1,171,313	1,906,979	CCA-21NOS	1,170,769	1,907,666
CCA-5NOS	1,171,201	1,907,066	CCA-22NOS	1,170,752	1,907,702
CCA-6NOS	1,171,261	1,907,100	CCA-23NOS	1,170,670	1,907,766
CCA-7NOS	1,171,191	1,907,114	CCA-24NOS	1,170,656	1,907,806
CCA-8NOS	1,171,241	1,907,127	CCA-25NOS	1,170,569	1,907,828
CCA-9NOS	1,171,110	1,907,185	CCA-26NOS	1,170,668	1,907,875
CCA-10NOS	1,171,139	1,907,280	CCA-27NOS	1,170,558	1,907,891
CCA-11NOS	1,171,038	1,907,284	CCA-28NOS	1,170,608	1,907,930
CCA-12NOS	1,171,080	1,907,297	CCA-29NOS	1,170,486	1,908,042
CCA-13NOS	1,170,965	1,907,372	CCA-30NOS	1,170,559	1,908,030
CCA-14NOS	1,171,001	1,907,449	CCA-31NOS	1,171,269	1,907,118
CCA-15NOS	1,170,928	1,907,490	CCA-32NOS	1,171,069	1,907,376
CCA-16NOS	1,170,933	1,907,505	CCA-33NOS	1,171,048	1,907,407
CCA-17NOS	1,170,857	1,907,507			

Coordinate System is Illinois State Plane East, NAD83 (feet)

Step I samples for COPC evaluation will be labeled as “CCA” samples (Chemical Characterization Assessment). Samples CCA-1NOS through CCA-33NOS will be collected (Figure 35). Sampling locations will be recorded using a DGPS unit with sub-foot accuracy in accordance with the methods described in USEPA-approved SOP SAS-03-03 and Section 7 of the Multi-Site FSP.

Step I samples will be analyzed for the parameters listed on Table 2. Analytical methods, preservatives and required volumes and containers for these analyses are also presented on Table 2.

Sediment samples will be labeled in accordance with USEPA-approved SOP SAS-03-01 from the Multi-Site FSP. Sampling locations will be recorded using a DGPS with sub-meter accuracy in accordance with the methods described in USEPA-approved SOP SAS-03-03 and Section 7 of the Multi-Site FSP.

The sediment cores will be collected using a barge-mounted drill rig or a vibrocore in accordance with USEPA-approved SOP SAS-07-03 and Section 4 of the Multi-Site FSP. The surface sample at each core could be collected with either the same sampling method used to assess sediment thickness (Section 6.6.5) or a Ponar sampling device as described in Section 4 of the Multi-Site FSP.

Sample intervals from sediment cores collected using a drill rig or vibrocore and not immediately submitted for laboratory analysis will be archived for future analysis. During the archiving process, a portion of the initial sample will be preserved in case the laboratory has questions regarding a particular sample or requires additional sample volume. By extending the sample hold times using the archiving process, any number of un-analyzed samples can also be archived and a sub-set of those can be selected for analysis to supplement the initial sample set following review and consideration of initial laboratory analytical results.

Whole sediment samples for PAH or metals analysis can be archived by immediately freezing and storing them at -20°C (USEPA, 2005) for later testing. Frozen samples will not be used for toxicity testing. Research suggests that archived samples can be stored for up to one year for SVOC analysis, and the sample extract can be stored an additional 40 days prior to analysis and still yield useful data (USEPA, 1994). Step I samples are not anticipated to be archived and used as part of the Step II process, and archived samples will be held for less than one year.

Sediment cores will be visually characterized, logged, and subdivided into the following 6-inch or 1-foot intervals for analysis:

- 0.0 to 0.5 feet;
- 0.5 to 1.5 feet;
- 1.5 to 2.5 feet; and
- 2.5 to 3.5 feet, etc.

Sediment samples will be collected and analyzed to compare COPC concentrations to SLs and the ambient sediment sampling results. Six samples (in addition to the surface sample) are anticipated to be submitted from each core to evaluate the vertical distribution of COPCs. In addition to the surface interval, the first two subsurface intervals (extending to 2.5 feet below the top of sediment) from each of the pre-selected sediment cores will be submitted for laboratory analysis of COPCs. Up to four additional intervals will be submitted from each core, and the selected intervals will be based on field observations. Therefore, up to 231 samples are planned for the Step I activities.

Continuous sediment intervals do not need to be submitted for analysis. Rather, sections that appear clean or contaminated relative to the overall core appearance may be selected for analysis while the remaining core intervals are archived for future laboratory analysis. Table 2 provides a summary of anticipated samples and analyses. Sample selection will be based on field observations and the presence or absence of MGP residuals. Samples below readily identifiable MGP residuals can be submitted to delineate the interface between impacted and non-impacted sediments in the River. Decisions regarding sample submission from each core will be determined in the field by the field team leader. The decision to submit archived sediment samples for analysis will occur following receipt and review of laboratory analytical data.

All 33 surface sediment samples will be analyzed for the COPCs identified in Section 3.8, including 34 alkylated PAHs (rather than the abbreviated list of PAHs), and the additional parameters of black carbon, and TOC. Ten of the collected surface sediment samples will also be used for toxicity testing. These sample results will be analyzed to evaluate potential toxicity for comparison with ambient results and for future reference during Step II sampling. Samples selected for toxicity testing will be analyzed for the additional parameters ammonia and sulfide.

In addition to the surface sediment samples, at least 20 of the deeper sediment samples will be submitted for analysis of the 34 alkylated PAHs, black carbon and TOC. These samples will provide additional data regarding source and distribution of impacts at depth in the sediment profile. As appropriate, surface and subsurface samples analyzed for the 34 alkylated PAHs may undergo further review and forensic analysis (i.e. hydrocarbon fingerprinting).

Up to 10 sediment cores (depending on the variation in strata) will be collected and submitted for analysis of geotechnical parameters for use in the FS. These parameters include:

- Atterberg limits;
- Grain size (sieve and hydrometer);
- Organic content (by loss on ignition); and
- Moisture content.

Field measurements to estimate shear strength will be collected using a pocket penetrometer. Geotechnical samples may be discrete intervals or composite samples, depending on observed conditions. Samples not immediately submitted for laboratory testing will be frozen and archived. These samples will be available for later laboratory or physical testing.

A composite sample will also be prepared for waste characterization by collecting and combining sediments from the drum(s) of investigative-derived waste. The composite sample will be analyzed for waste characterization parameters using Protocol B and other parameters as required by the landfill to identify disposal options for investigative waste and for FS purposes. Analytical requirements will be discussed with landfill representatives prior to sample collection to ensure the analysis is appropriate.

The drilling/vibrocore and laboratory subcontractors will be identified to the USEPA prior to initiating field activities and the subcontractors' SOPs will be provided to the USEPA for review and approval. The analytical and geotechnical results will be presented in the RI Report.

Following receipt of the Step I results, a brief technical memorandum will be prepared that summarizes Step I data on maps and tables including the following:

- An assessment of current conditions and the distribution of COPCs;
- Recommendations to submit archived samples for laboratory analysis to further evaluate areas of concern; and
- An evaluation of toxicity and forensic results to further understand issues related to MGP residuals.

The data packages will be reviewed to assess if ambient conditions are statistically different from conditions within the OU and if additional assessment of the potential risk to human or ecological receptors is required. The technical memorandum will include recommendations and an approach for Step II sediment sampling, if necessary.

6.6.7 Step II Sampling

Additional investigation elements for the site may be necessary for further characterization or delineation of impacts. Specific elements of Step II sampling will be summarized in a technical memorandum that will be prepared prior to field mobilization. Potential elements include the following:

- COPC analysis in specific locations to further delineate distribution;
- Additional toxicity testing;
- Bioavailability analysis; and
- Benthic community structure evaluation.

6.6.7.1 COPC Analyses

If warranted, additional sediment cores will be collected to refine the COPC distribution in the river sediment. This will include collecting sediment samples with a range of PAH concentrations to provide additional data that can support further toxicity sampling (if necessary). This sampling would also focus on delineating the extent of MGP residuals observed during Step I activities.

6.6.7.2 Toxicity Testing

Results of the previously performed sediment investigation and the Step I PAH concentrations will be used to focus the toxicity testing sample locations and PAH concentration ranges. Up to ten samples may be selected for additional analysis based on the total PAH (34) concentration. Samples selected for toxicity testing will be distributed over a range of PAH concentrations from less than 10 up to 1,000 parts per million (ppm).

6.6.7.3 Bioavailability Analysis

The portion of PAH (as measured in the laboratory) with potential bioavailability may be evaluated using TOC and black carbon analysis. These measurements will be used to predict potential bioavailability in sediment using an equilibrium partitioning approach as discussed in Section 3.6.3 of the Multi-Site RAF.

6.6.7.4 Benthic Community Structure Assessment

If benthic community structure assessment is performed, a qualified field biologist will assess the benthic community structure, as described in Section 4 of the Multi-Site FSP using sediment samples collected from a grab sampler. The samples for the benthic community structure assessment will be collected at sediment core locations with COPC concentrations above the ecological SLs in the top six-inch interval, and, if possible, located near toxicity testing sample locations. The community structure assessment will be used to evaluate the abundance and diversity of bottom-dwelling species and evaluate the overall ecological integrity of the River.

The sediment will be collected from the top six inches, which is generally considered the biologically activate zone for burrowing and feeding in freshwater benthic organisms. The field locations will be documented in accordance with the Multi-Site FSP.

6.7 Soil Vapor Evaluation

No soil vapor investigations have been conducted on the North Station OU and MGP structures are known to have been located within and around current building footprints. Appendix E describes a multiple-lines-of-evidence evaluation for the potential for VI on the North Station OU, based on building placement, position of historic MGP structures, available soil and groundwater data, and USEPA's *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance) (EPA530-D-02-004,* November 2002). During a meeting with USEPA and Integrys on December 17, 2010, USEPA suggested that any building located over a former MGP structure should be considered a candidate for VI investigation and subslab soil gas sampling.

On the ComEd parcel, there are two buildings, the substation control building (Building 1) and the maintenance building (Building 2), located over former structures; and there are two buildings, oil pump houses #1 and #2 (Buildings 3 and 4) located adjacent to affected soil and over affected groundwater. Other structures on site that are considered for VI evaluation because of their placements relative to impacted soil and groundwater are Building 5, the Shiani Furniture Building on the Division parcel; and Building Groups 6, 7 and 8, multi-unit apartment buildings located across Crosby and Hobbie Streets from the OU. Subslab samples, sump headspace samples and exterior soil gas samples are proposed to evaluate potential VI at the buildings of concern. Soil gas samples will be identified as NOS-SG1 through NOS-SG17 (Station-Soil Gas #) and are summarize below (Figure 34):

- Two sump headspace samples (NOS-SG1HS and NOS-SG2HS) will be collected in the lower level of Building 1 where sumps for control of groundwater seepage are located. This building lies over a former 750,000 gallon above-ground oil tank;
- One subslab probe (NOS-SS3) will be installed under the Building 2 on the southern portion of the ComEd parcel. This building lies over a former gas holder;
- Four exterior soil gas probes (NOS-SG4 through NOS-SG7) will be installed around Building 5 on the Division parcel, north of the former MGP operations;
- Six exterior soil gas probes (NOS-SG8 through NOS-SG13) will be installed in the parkway on the east side of Crosby Street, east of the former MGP operations on the ComEd parcel;
- Three exterior soil gas probes (NOS-SG14 through NOS-SG16) will be installed in the parkway on the south side of Hobbie Street, south of the former MGP operations on the ComEd parcel; and
- Two subslab probes (NOS-SS17 through NOS-SS18) will be installed in the units of Building Group 6 that are located over the former MGP building that contained a tar vat.

No subslab samples are proposed for Buildings 3 and 4 unless additional information is obtained from ComEd that suggests they are occupied by substation personnel for sufficient duration to represent an exposure pathway of concern. In comments provided on the Marinette Former MGP Site-Specific Work Plan, Revision 1, received on September 1, 2011, USEPA recommends that "any buildings that could be occupied (current or future) for 1 hour or more per day should be considered in the VI assessment." When use and occupancy information for Buildings 3 and 4 is obtained from the owner, this criteria will be will be utilized to consider whether additional VI assessment is appropriate.

The exact locations of subslab and exterior soil gas probes may be altered, based on observations made during field operations and installation feasibility. Locations may be moved to avoid obstructions or access issues.

A detailed evaluation of VI for the site is presented in Appendix E. VI evaluation for future land use scenarios, potentially impacted utility corridors, and for any additional buildings of concern identified following analysis of the current RI sampling plan will be conducted after results of the proposed sampling are received. Data evaluation for the current scope of the RI will include consideration of the need for additional VI evaluation.

During soil vapor and subslab probe installation, up to two subsurface soil samples may be collected from proposed borings for chemical analysis. Subsurface soil samples for chemical analysis will be collected between 2 feet bgs and the termination depth (one foot above the water table). Selection of subsurface soil samples will be based on visual observations or elevated PID readings following the sampling decision tree in Table 4, and samples will be classified following USEPA-approved SOP SAS-05-02 from the Multi-Site FSP. If no evidence of impacts is present in a boring, a sample will be collected from the 2-4 feet bgs interval. If subslab and soil gas probes are installed using a hammer drill and drive rods such that the soil cannot be logged or sampled during installation, then soil samples will not be collected at that location.

Up to four geotechnical samples will be collected from soil gas probe boring locations and tested for grain size distribution, moisture content, bulk density, and specific gravity in accordance with Table 2. Samples will be selected to represent the soil in the area of the probes. If subslab and soil gas probes are installed using a hammer drill and drive rods because sampling locations are not accessible by a direct-push rig and such that the soil cannot be logged or sampled during installation, geotechnical samples will be collected from nearby locations that are likely to represent soil where the probes are installed.

6.7.1 Exterior Soil Gas Sampling

Soil gas probes will be installed and sampled per the procedures outlined in USEPA-approved SOP SAS-11-06 (Appendix F). At each proposed exterior soil gas sampling location, one or more nested probes will be installed, based on the depth to the water table as follows:

- One probe will be installed in the soil column at 3.5 to 4 feet bgs. If the depth to the water table is 5.5 feet bgs or less, only one probe will be installed.
- A second soil gas probe will be installed directly above the water table if the depth to groundwater is 6 feet bgs or greater.
- If the unsaturated zone is greater than 8 feet, a third probe may be installed midway between the shallow probe and the probe located above the water table.

The exact locations of exterior soil gas probes may be altered based on observations made once site access is gained and during field operations. Locations may be moved closer to affected soil observed during soil borings or moved to avoid obstructions or access issues.

Installing nested probes at multiple depth intervals will allow evaluation of vertical attenuation over distance. For nested probes at varying depths, the probes will be installed in the same borehole and the hole then packed with sand and bentonite per USEPA-approved SOP SAS-11-06. Probes driven into the ground using rods cannot be nested in this way and will instead be nested in separate holes in close proximity. Soil gas probes nests will be identified as NOS-SG#S (shallow), NOS-SG#D (deep) or NOS-SG#M (mid-depth).

For the deeper soil gas sampling locations, a direct-push rig will advance a probe hole through the soil and soil samples may be collected during probe advancement. One or more soil vapor probes will then be advanced to the desired depth within the probe hole. After the probe is placed at the desired depth, a filter pack containing sand will be set to within 2 inches above and below the vapor probe. Above the filter pack, a seal of cement-bentonite grout or granular bentonite will be placed up to the ground surface. If granular bentonite is used above the filter pack, the granular bentonite will be hydrated in 2-foot lifts up to ground surface (USEPA-approved SOP SAS-11-6). This granular bentonite will provide an airtight seal between the soil gas probe and the ambient air. A vault and well cover will be installed to make the probe locations permanent. Digital photos will be taken of each sample location and sample assembly. Probes will not be installed shallower than 3 feet bgs. Each probe will be allowed to set for at least 24 hours before sample collection.

Sampling can commence after the probe assembly at each location is complete, the assembly has been purged, and the probes have cured for 24 hours (USEPA-approved SOP SAS-11-06). Sample location information, and meteorological conditions (e.g., temperature, barometric pressure, wind speed/direction, and relative humidity) will be recorded on a Field Data Air Sampling Form. Meteorological data will be obtained online from the nearest National Weather Service monitoring station.

Soil gas samples will be collected in a 1-liter canister connected to a 200-mL/min flow regulator. The sample canister valve will be opened to begin sample collection. The start time and initial vacuum when sample collection starts will be recorded on the Field Data Air Sampling Form. The laboratory-provided flow regulators will be calibrated for a 5 to 10 minute sample duration, which correlates to a flow rate of 100 to 200 mL/min. The sample canister valve will be closed when the vacuum gauge indicates approximately 5 inches Hg (mercury) of vacuum remains in the canister. Sample collection should take approximately 5 minutes for a 1-liter canister connected to a 200-mL/min flow regulator. The time that sample collection is stopped and final vacuum will be recorded on a Soil Vapor Sampling Field Form contained in the SOP. The flow regulator/particulate filter and vacuum gauge assembly will be removed and the laboratory-supplied brass plug on the canister will be replaced. The sample tubing assembly will be disconnected and the plug on the soil vapor probe will be replaced.

The sample canister will be labeled with the sample name, date and time of collection. The canister label information plus the canister and flow controller serial numbers, and the final vacuum gauge reading will be recorded on the chain-of-custody. Samples will not be chilled or subjected to extreme temperature or pressure fluctuations. Samples will be shipped for analysis of soil gas COPCs (Tables 1 and 2) by USEPA Method TO-15, and for , , and methane by ASTM Method 1946 or USEPA Method 3C.

6.7.2 Subslab Vapor Sampling

Subslab vapor probes will be installed and sampled per the procedures outlined in USEPA-approved SOP SAS-11-01 (Appendix F). At each proposed subslab vapor sampling location, at least two nested probes will be installed. One probe will be installed in the soil column directly (approximately one foot) above the water table. This will provide an estimate of volatilization at the water table. The other probe will be installed just below the building slab to provide an estimate of soil vapor concentrations beneath the slab. If the unsaturated zone is sufficiently thick (greater than 8 feet), a third probe may be installed midway between the other two probes. Installing nested probes at multiple depth intervals will allow evaluation of vertical attenuation over distance. Soil gas probes nests will be identified as NOS-SG#SS (subslab shallow) and NOS-SG#SD (subslab deep).

The exact locations of subslab soil gas probes may be altered based on observations made once site access is gained and during field operations. Locations may be moved closer to affected soil observed during soil borings or moved to avoid obstructions or access issues. If geo-probe and hand equipment (e.g. drive rods, hand augers) are not successful for interior probe installation, or if access issues prohibit installation, probes will be moved to the exterior of the building.

For the subslab soil vapor probe locations, a rotary hammer drill and a clean drill bit will be used to create a shallow (2.5 cm or 1 inch) outer hole that partially penetrates the slab. Areas of visible staining or known previous chemical spills will be avoided. After completing the outer hole, a rotary hammer drill will be used to create a smaller diameter inner hole (0.8 cm or 5/16 inch) through the remainder of the slab and approximately 7 to 8 cm or 3 inches into subslab material. Drilling into subslab material will create an open cavity that will prevent obstruction of probe inlets during vapor sampling. After completing drilling, the outer hole will be cleaned using a towel moistened with deionized water to promote a good seal during cement application.

Subslab vapor probes will be set in holes such that the fittings rest at the base of the outer hole and the top of the probes are completed flush with the slab. Each probe will have recessed stainless steel or brass plugs to minimize interference with daily building use. A quick-drying Portland cement that expands upon drying (to ensure a tight seal) will be mixed with deionized water to form slurry that will be injected or pushed into the annular space between the probe and outside of the outer hole. Cement will be allowed to cure for at least 24 hours prior to sample collection.

Prior to sampling at each soil gas location, the vapor probes will be purged and the sampling assembly will be subjected to two leak tests. The first is a chemical leak test using helium to detect whether there are any leaks in the sample train assembly. The second is a mechanical leak test to ensure no leaks are present in the connections to the canister. Leak tests will follow procedures in USEPA-approved SOPs SAS-11-01 and SAS-11-06.

Sampling can commence after the probe assembly at each location is complete, the assembly at each location passes both leak tests, the assembly has been purged and the probes have cured for 24 hours. Sample collection, labeling, handling and shipping will proceed as described in Section 6.7.1 for exterior soil gas sampling.

6.7.3 Sump Headspace Sampling

Sump headspace samples will be collected in buildings where sumps are present that provide a preferential pathway for affected groundwater or soil gas to enter the building. At the selected sump, one vapor grab sample will be collected. Prior to sample collection, the sump will be sealed off except for a sampling port that will allow the vapor sample to be withdrawn from the headspace after the sump is sealed off. Sump headspace samples will be identified as NOS-SG#HS.

Prior to sample collection, an indoor air sampling survey will be conducted of the building interior to document the presence of any chemicals or materials that may contribute to background concentrations of COPCs in the sampling area.

Sampling can commence after the sump seal has cured for 24 hours. Sample location information, and meteorological conditions (e.g., temperature, barometric pressure, wind speed/direction, and relative humidity) will be recorded on a Field Data Air Sampling Form. Meteorological data will be obtained online from the nearest National Weather Service monitoring station. Sample collection, labeling, handling and shipping will proceed as described in Section 6.7.1 for exterior soil gas sampling.

6.8 Disposal of Investigation-Derived Waste

Investigative wastes will be placed in containers during field investigation activities in anticipation of offsite disposal. Confirmation that the disposal facilities meet the requirements of the OSR (USEPA September 1993) for the disposal of investigation-derived waste will occur prior to undertaking any disposal activities.

Representative samples for disposal purposes will be obtained and provided as required by the disposal authority through which the wastes will be managed and disposed. A composite sample of soil will be prepared for waste characterization by collecting material from soil cuttings. Representative groundwater and decontamination water samples will also be prepared for waste characterization. The groundwater, decontamination water and composite soil samples will be sent to a fixed-based analytical laboratory for analysis of waste disposal parameters that will be specified by the landfill. All disposal activities will be completed in accordance with applicable state and federal regulations and the methods described in Section 9 of the Multi-Site FSP.

6.9 Record Keeping

Details of field and laboratory records and data management and storage are provided in the USEPA-approved Multi-Site QAPP, Multi-Site FSP, and SOP SAS-01-02.

6.10 Sample Analysis and Validation

Pace Analytical and TestAmerica are the proposed fixed laboratories for analysis of chemical samples of soil, groundwater, surface water, and sediment. STAT Analysis Corporation (STAT) is the proposed fixed laboratory for chemical RI analysis of soil gas samples. Pace Analytical, TestAmerica and STAT have already been approved in the Multi-Site QAPP. Reporting and detection limits for the labs will be verified prior to sample collection to ensure that the Practical Quantitation Limits are met.

Table 2 summarizes the proposed sampling and analysis plan for the North Station OU and includes samples to satisfy quality assurance/quality control requirements in accordance with Section 2 of the Multi-Site QAPP and USEPA-approved SOP SAS-04-03 from the Multi-Site FSP. As described in Section 6, the dynamic work plan approach will be used and additional samples (including QA/QC samples) may be collected.

Laboratory procedures, field measurements, and sample results will be verified and/or validated as discussed in the Section 4 of the Multi-Site QAPP.

6.11 Data Evaluation and Tabulation for Risk Assessment

Verified and/or validated data will be entered into a database and tabulated for use as described in the Multi-Site QAPP. Procedures for assessing the precision, accuracy, representativeness, completeness, and comparability of field and analytical laboratory data are described in Section 4 of the Multi-Site QAPP and USEPA-approved SOPs SAS-04-01, SAS-04-02, and SAS-04-03 from the Multi-Site FSP. Data will be evaluated to assess if the DQOs identified in the Multi-Site QAPP have been met.

Analytical results will be organized in a logical manner such as by sample location number, sample type, or sample area. Analytical tables will indicate the unique sample identification number corresponding to the sample/location/well name, sampling date and time, sample depth, detection limits, analytical results (following the units of measurement presented in the Multi-Site QAPP Table 9), and validation qualifiers, if appropriate. Data may be presented in summary tables, graphs, or as plan or cross-sectional views with COPC concentrations, as determined necessary.

Data sets may be created for each medium and may include summary statistics such as detection frequency, arithmetic mean concentration, maximum detected concentration, standard deviation, and 95% upper confidence limit of the mean.

7 REMEDIAL INVESTIGATION REPORT

An RI Report will be prepared at the conclusion of investigation activities in general accordance with the USEPA RI/FS guidance document (USEPA 1988). The RI Report will include the following information and documentation, as appropriate, in accordance with Task 4 of the SOW attached to the AOC:

- A description of field procedures and methods used during the RI;
- A discussion of the nature and rationale for any significant variances from the scope of work described in this RI/FS SSWP;
- The data obtained during the RI and previously collected data of useable quality. This will include analytical data, field measurements, etc. To the extent practicable, RI and previously collected data will be presented in figures and tabular formats;
- The results of an assessment to evaluate if the RI acceptance/performance criteria were met as specified in the Site-Specific QAPP;
- The methods and rationales used in evaluating RI and previously collected data;
- Identification of MGP-related residuals. Observation of discolored/stained soil alone does not imply the presence of MGP-related residuals. Similarly, sampling locations where no MGP residuals were visibly observed does not also mean that all soil analytical results were below SLs. Notations of sheens, LNAPL, and DNAPL are noted in the field to illustrate the distribution of more highly affected areas of the site and adjacent properties and inform the RI/FS process.
- Conclusions regarding extent and nature of MGP residuals in the media of concern;
- A revised Site-Specific CSM with a discussion of environmental fate and transport of COPCs;
- A BLRA Report as discussed in the Multi-Site RAF;
- A discussion of anticipated future land use and reuse assessment; and
- Any supporting material for RI data, including boring logs, monitoring well construction diagrams, groundwater sampling logs, laboratory analytical reports, and similar information.

8 FEASIBILITY STUDY SCOPE OF WORK

The FS will be completed in accordance with the USEPA RI/FS guidance document (USEPA 1988). Additional guidance is provided in the Multi-Site FS Support Document (Integrys 2009).

8.1 Development and Screening of Alternatives

Task 6 of the SOW requires the development and screening of site-specific remedial alternatives for evaluation in the FS. The site-specific remedial alternatives will build on the Multi-Site FS Document (Integrys 2009). A Site-Specific Alternatives Screening Technical Memorandum will be prepared to summarize the site-specific alternative analysis. The memorandum will document the methods, rationale, and results of the alternatives screening process and will include elements in the following sections.

8.1.1 Development of Remedial Action Objectives

Remedial action objectives (RAO) will be developed focusing on eliminating or minimizing substantial risks to human health and the environment. Prior to developing these objectives, the contaminants, media of concern, potential pathways, and contaminant levels that are protective of human health and environment will be specified.

8.1.2 Identify Areas or Volumes of Media

The areas or volumes of media where response actions may apply will be delineated and will consider the protective requirements identified in the RAOs. These areas or volumes will form the foundation for developing and screening remedial technologies.

8.1.3 Identify, Screen, and Document Remedial Technologies

Technologies will be identified based on the feasibility of implementation at the OU. The alternatives will be screened based on effectiveness, ability to implement, and cost as described below:

- **Effectiveness Evaluation –** This will consider the capability of each remedial alternative to protect human health and the environment. Each alternative will be evaluated based on the protection provided and the achievable reductions in toxicity, mobility, or volume of COPCs.

- **Implementation Evaluation –** This will evaluate the availability of technologies and determine both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Innovative technologies will be considered throughout the screening process if there is a potential for better treatment performance or implementation, few or lesser adverse impacts, or lower costs than demonstrated technologies.

- **Cost Evaluation –** This will include conceptual estimates of capital costs, annual operation and maintenance (O&M) cost, and a present worth analyses. These estimates will be prepared based on preliminary conceptual engineering for major construction components and unit costs of capital investment and general O&M costs available from USEPA guidance documents or from experience with similar systems or projects.

8.1.4 Assemble and Document Alternatives

A draft Remedial Alternatives Screening Memorandum for the FS will be prepared to document the preliminary FS work tasks described above and will address each affected media or operable unit. The draft memorandum summarizing the results of the preliminary screening will be submitted to USEPA for review and comment. The developed list of potential remedial alternatives will undergo preliminary screening to reduce the number of technologies and alternatives while preserving a range of options. In addition, the ARARs associated with each of the assembled alternatives will be summarized.

8.2 Detailed Analysis of Alternatives

Task 7 of the SOW requires a detailed analysis of remedial alternatives be presented to USEPA for use in selecting the preferred remedy. This analysis will use the Multi-Site FS documents as the framework. Remedial alternatives that pass the initial screening will be further evaluated. The detailed evaluation will include an analysis of each remedial option against nine criteria as set forth in 40 CFR 300.430(e)(9)(iii). These nine criteria are as follows:

- **Overall Protection of Human Health and the Environment –** Alternatives will be assessed to determine short- and long-term ability to protect human health and the environment from unacceptable risks from hazardous substances, pollutants, or contaminants at the OU by eliminating, reducing, or controlling exposures to levels established during development of remediation goals consistent with 40 CFR 300.430(e)(2)(i). Overall protection of human health and the environment draws on other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

- **Compliance with ARARs –** Alternatives will be assessed for compliance with ARARs under federal environmental laws, state environmental laws, or facility citing laws, unless grounds are provided for invoking one of the waivers under 40 CFR 300.430(f)(1)(ii)(C).

- **Long-Term Effectiveness and Permanence –** Alternatives will be assessed for long-term effectiveness, permanence, and certainty of success. Factors that may be considered include the risk from untreated waste or residuals remaining at the conclusion of remedial activities, and the adequacy and reliability of controls necessary to manage treatment residuals and untreated waste (e.g., containment systems and institutional controls).

- **Reduction of Toxicity, Mobility, and Volume through Treatment –** Alternatives will be assessed for the use of recycling or treatment methods that reduce contaminant toxicity, mobility, or volume. This will include how the treatment will reduce hazards from the principal threats within the OU. The remedial action alternatives will be assessed for the processes used, the type and quantity of materials treated, the specification of which reductions are occurring, the degree that the treatment is irreversible, and the type and quantity of residuals following treatment, considering the persistence, toxicity, mobility and propensity to bioaccumulate.

- **Short-Term Effectiveness –** Alternatives will be assessed for potential short-term risks to the community during implementation, potential impacts on workers, the effectiveness and reliability of protective and mitigating measures, potential environmental impacts, and the time until protection is achieved.

- **Implementation –** Alternatives will be assessed for the ability to implement at the OU by considering the technical feasibility, ease of construction and operation, reliability, administrative feasibility, the ability to monitor the effectiveness, and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions). The availability of necessary services, materials, equipment, specialists, and prospective technologies will be evaluated.

- **Cost –** Alternatives will be assessed for capital costs (both direct and indirect), annual O&M costs, and net present value of capital and O&M costs.

- **State Acceptance –** Assessment of Illinois EPA concerns may not be completed until comments on the RI/FS are received, but these concerns may be discussed to the extent possible in the Proposed Plan issued for public comment. Concerns that will be assessed include the Illinois EPA's position and key concerns related to the preferred alternative and other alternatives, and Illinois EPA comments on ARARs or the proposed use of waivers.

- **Community Acceptance –** Alternatives will be assessed for components that community members support, have concerns about, or oppose. This assessment may not be completed until comments on the Proposed Plan are received.

8.2.1 Comparison of Alternatives

A comparative analysis will be performed after the remedial alternatives have been assessed against the nine evaluation criteria. This analysis will compare all of the remedial alternatives against each other for each criterion. USEPA will identify and select the preferred alternative.

8.2.2 Alternatives Analysis for Institutional Controls

Alternatives that rely on institutional controls will be evaluated using the following criteria:

- **Overall Protection of Human Health and the Environment –** Includes specific institutional control components that will ensure the alternative will remain protective and describes how theses specific control will meet remedial action objectives.
- **Compliance with ARARs –** Evaluates how each institutional control complies with Federal and State ARARs.
- **Long-Term Effectiveness –** Assesses the adequacy and reliability of institutional controls and how long the institutional control must remain in place.
- **Short-Term Effectiveness –** Assesses the time required to impose an institutional control.
- **Implementation –** Includes research and documentation that the proper entities (e.g., potentially responsible parties, state, local government entities, local landowners, and conservation organizations) are willing to enter into any necessary agreement or restrict covenant with the proper entities and/or that laws governing the restriction exist or allow implementation of the institutional control.
- **Cost –** Includes the cost to implement, maintain, monitor, and enforce the institutional control.
- **State and Community Acceptance –** Addresses the community's concerns for the use of institutional controls. Community acceptance may be re-evaluated as necessary during public comment on the FS.

8.3 FS Report

A draft FS Report will be prepared to summarize the activities performed and to present the associated results and conclusions. The report will include a summary of the initial screening study and will present the detailed analysis of remedial alternatives considered as a basis for developing a Record of Decision.

The FS Report is anticipated to include the following sections:

- Introduction and Site Background;
- Development of Remedial Action Objectives and General Response Actions;
- Identification and Screening of Remedial Technologies;
- Development and Initial Screening of Remedial Alternatives;
- Detailed Analysis of Alternatives;

- Comparative Analysis of Alternatives; and
- Summary and Conclusions.

The feasible technology options for remediation, if warranted, will be identified for each general response action, and the results of the remedial technologies screening will be described. Remedial alternatives will be developed by combining technologies identified in the screening process. The results of the initial screening of remedial alternatives will be described with respect to effectiveness, ability to implement, and cost. Final screening against the nine comparative criteria and the comparison of remedial alternatives will be presented with a final recommended remedial alternative. A description of the key requirements for implementation of the recommended alternative and an estimated construction will be presented in the summary and conclusions section of the report.

9 SCHEDULE

Figure 36 presents a preliminary project schedule for the major tasks to be performed in support of the former North Station OU RI/FS. Due to the seasonally-dependent sampling events, the overall schedule is dependent on USEPA approvals.

The preliminary schedule assumes the following:

- Approved subcontractors will be available during the time periods needed;
- Four rounds of quarterly groundwater monitoring from the proposed new wells will be collected;
- Analytes will be deleted as groundwater sampling parameters after collecting two rounds of quarterly groundwater monitoring data if concentrations are non-detect, below screening values, or below concentrations observed in upgradient wells;
- Groundwater sampling frequency may be reduced as agreed upon with USEPA after collecting one year of quarterly groundwater monitoring data; and
- Treatability testing is not included; however, if treatability studies are identified during the RI, the schedule will be modified when the scope of work is identified.

A revised schedule may be submitted to USEPA at least 15 days following approval of the SSWP with the first monthly progress report.

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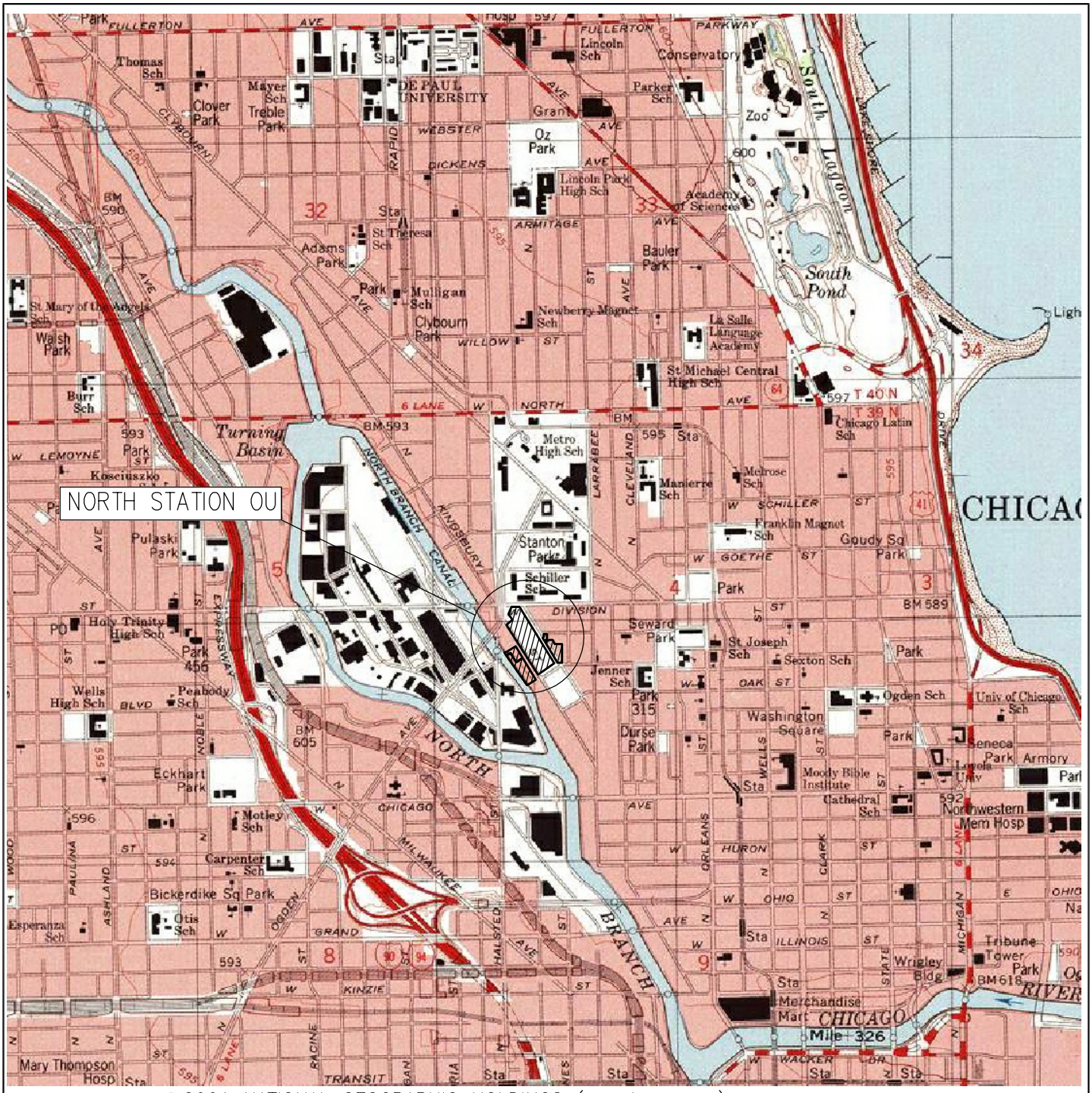
FIGURES



SOURCE: TOPO! © 2001 NATIONAL GEOGRAPHIC HOLDINGS (www.topo.com)

NORTH STATION OPERABLE UNIT LOCATION MAP

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

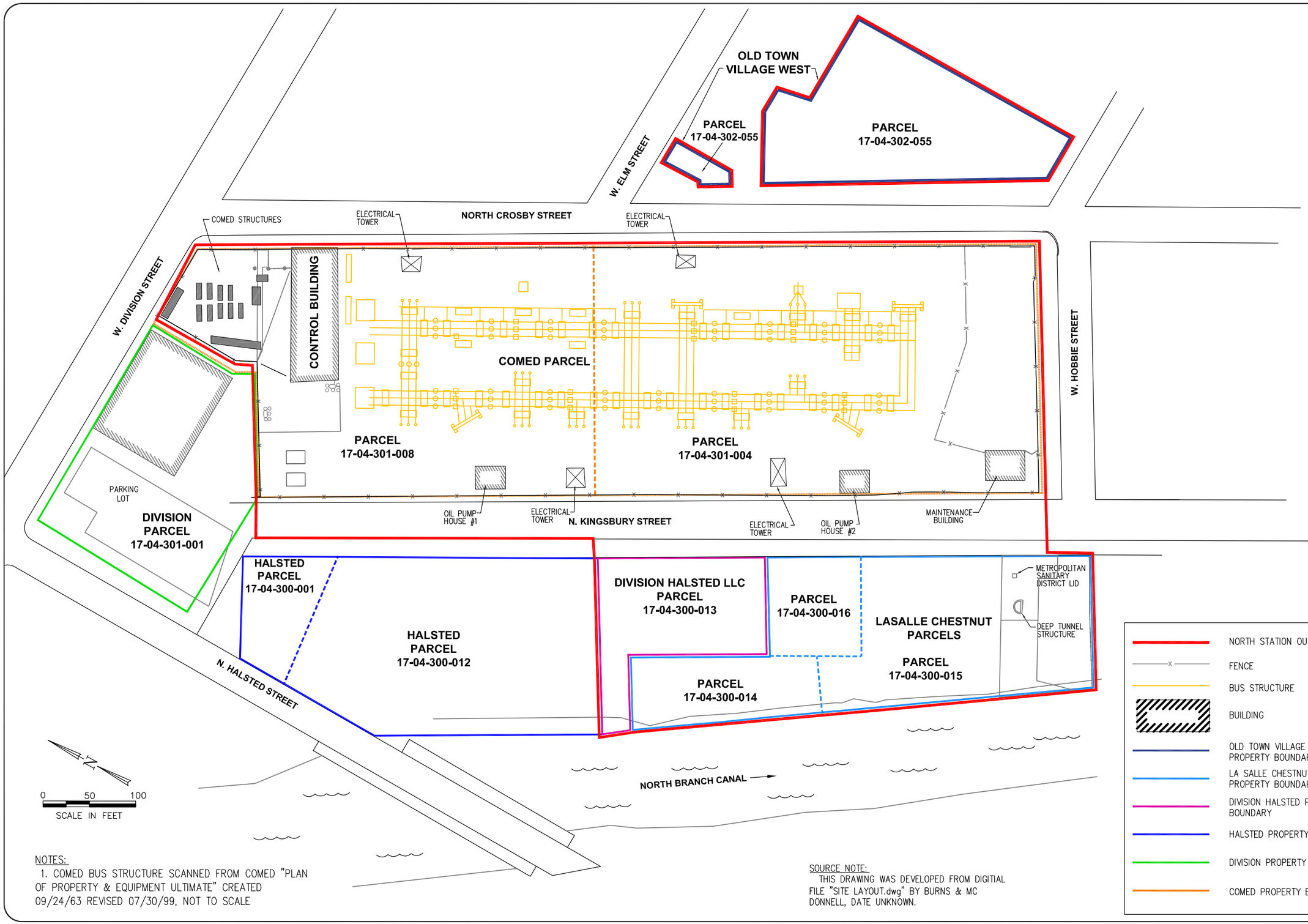
NATURAL RESOURCE TECHNOLOGY

DRAWN BY: RLH 08/04/11 APP'D BY: RJK DATE: 08/04/11

PROJECT NO. 2034/5

DRAWING NO. FIG-1

FIGURE NO. 1



NOTES:
1. COMED BUS STRUCTURE SCANNED FROM COMED "PLAN OF PROPERTY & EQUIPMENT ULTIMATE" CREATED 09/24/63 REVISED 07/30/99, NOT TO SCALE

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "SITE LAYOUT.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

DRAWN BY: RLH DATE: 08/04/11
CHECKED BY: SLM DATE: 08/04/11
APPROVED BY: SLM DATE: 08/29/11
DRAWING NO: FIG-2
REFERENCE:.

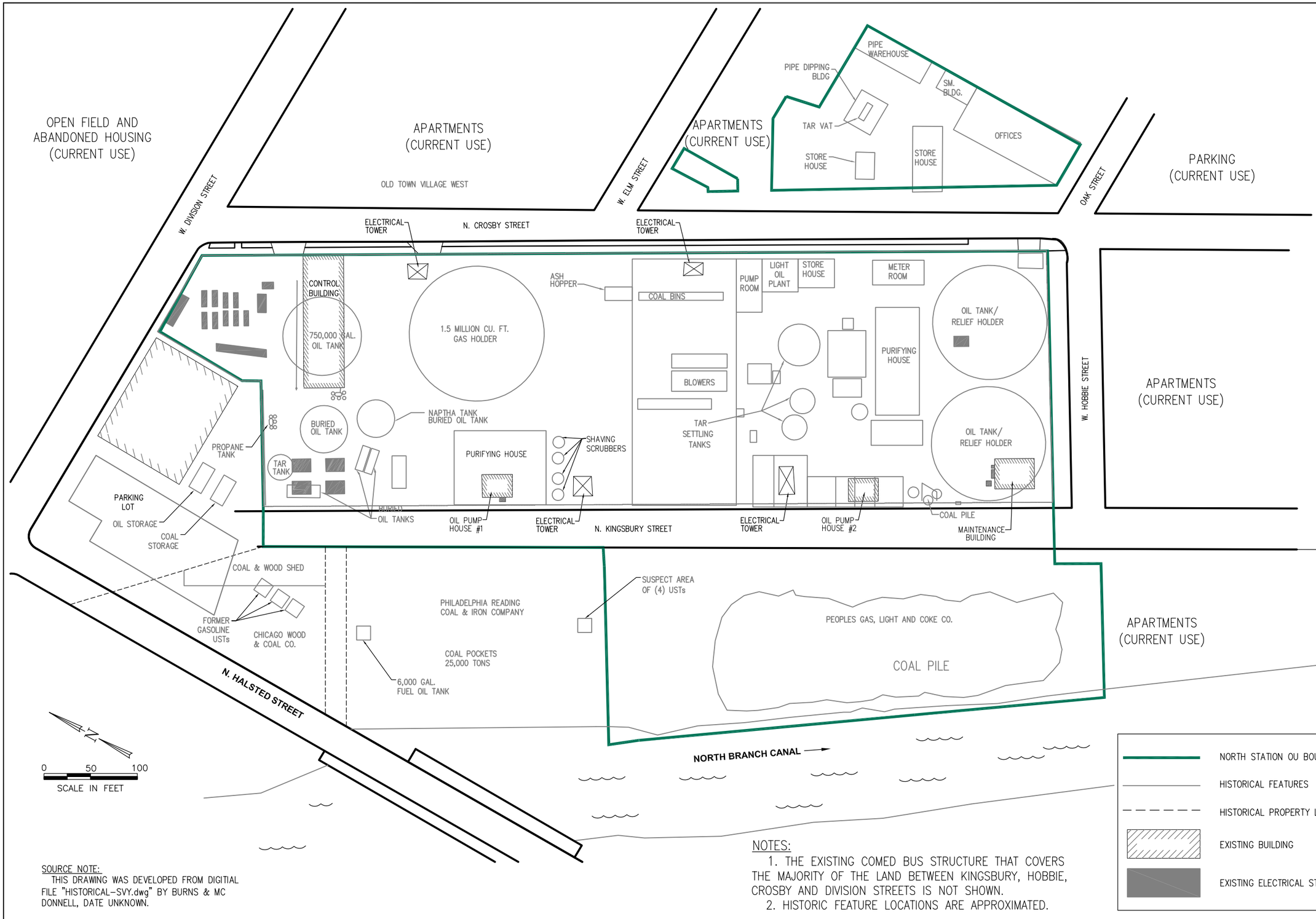
NORTH STATION OU PARCEL MAP

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/4.0

FIGURE NO.
2



SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "HISTORICAL-SVY.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

NOTES:
1. THE EXISTING COMED BUS STRUCTURE THAT COVERS THE MAJORITY OF THE LAND BETWEEN KINGSBURY, HOBBIE, CROSBY AND DIVISION STREETS IS NOT SHOWN.
2. HISTORIC FEATURE LOCATIONS ARE APPROXIMATED.

DRAWN BY: RLH/SJD DATE: 08/10/11
CHECKED BY: RJK DATE: 08/10/11
APPROVED BY: SLM DATE: 08/30/11
DRAWING NO: FIG-3
REFERENCE:.

HISTORICAL MGP STRUCTURES AND AREA FEATURES

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 2034/5

FIGURE NO. 3

DRAWN BY: RLH DATE: 08/05/11
CHECKED BY: RJK DATE: 08/05/11
APPROVED BY: SLM DATE: 08/24/11
DRAWING NO: FIG-4
REFERENCE: aerial com.esri.esrimap.jpg

NORTH STATION OPERABLE UNIT AND AREA ZONING MAP

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/4.0

FIGURE NO.
4

LEGEND

- November 1999 Boring
- Air Sampling Site
- Excavation Confirmation Sample
- Excavation Boundary
- Approximate Site Boundaries
- Historical Features

N

0 15 30 45 60 Feet

SOURCE:
DIGITAL FILE "DRAFT–BARR 30.pdf"
FIGURE 2, BARR, 2001.

INTERIM REMEDIAL ACTION
ComEd PARCEL

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

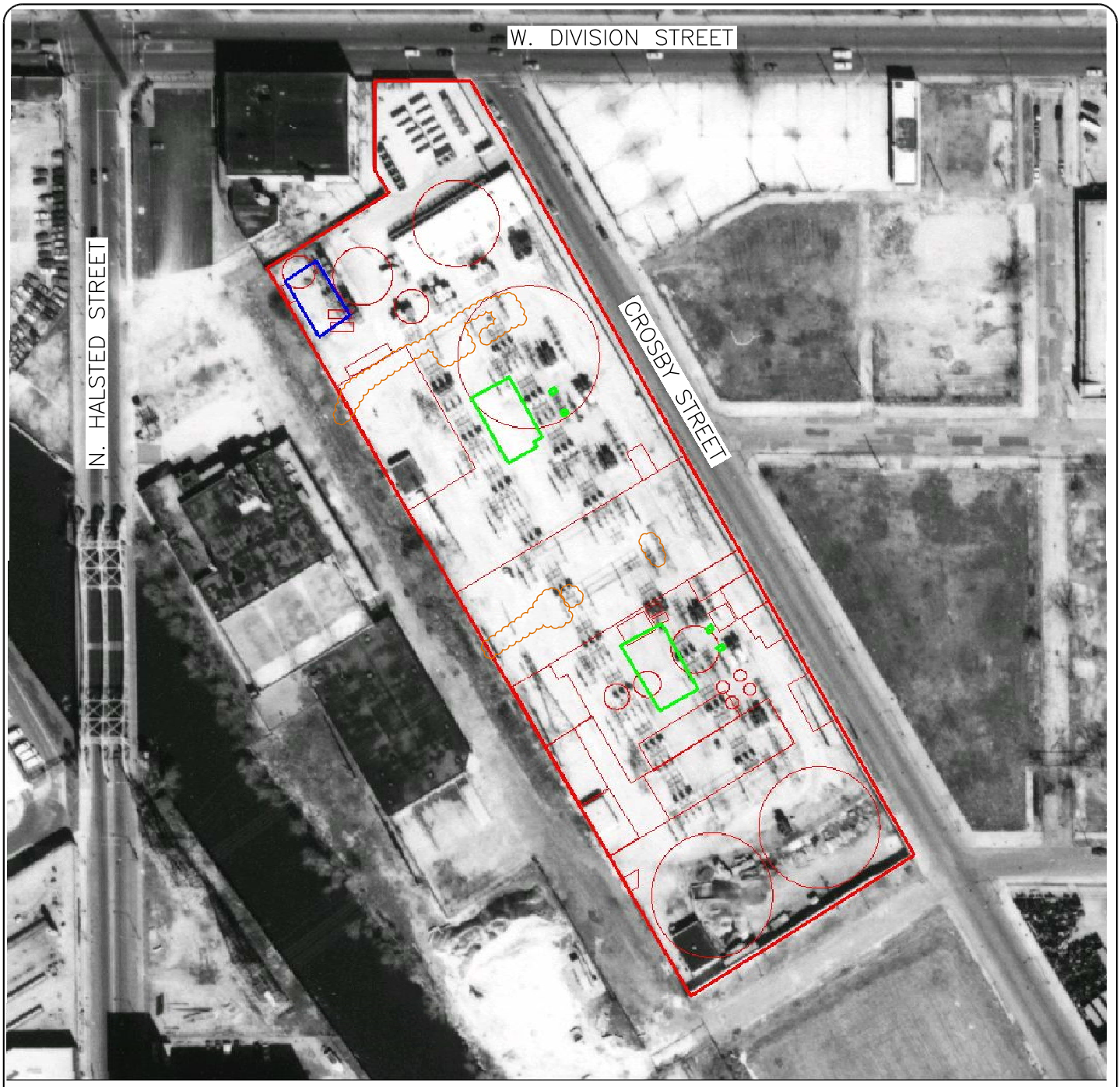
NATURAL RESOURCE TECHNOLOGY

DRAWN BY: RLH 06/10/11 APP'D BY: RJK DATE: 06/10/11

PROJECT NO. 2034/4.0

DRAWING NO. FIG 5

FIGURE NO. 5



N

50 0 50 100 150 Feet

SOURCE:
DIGITAL FILE "DRAFT–BARR 31.pdf" FIGURE 3, BARR, 2001.

Legend

- Peoples Gas Excavated Area
- Estimated Location of ComEd Remedial Activities
- Approximate Site Boundary
- Historical Features
- Areas Reported by ComEd as Excavated in Fall 2002 for Installation of Conduits and Cables. Depths Unreported.

ADDITIONAL REMEDIAL ACTIVITIES
ComEd PARCEL

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

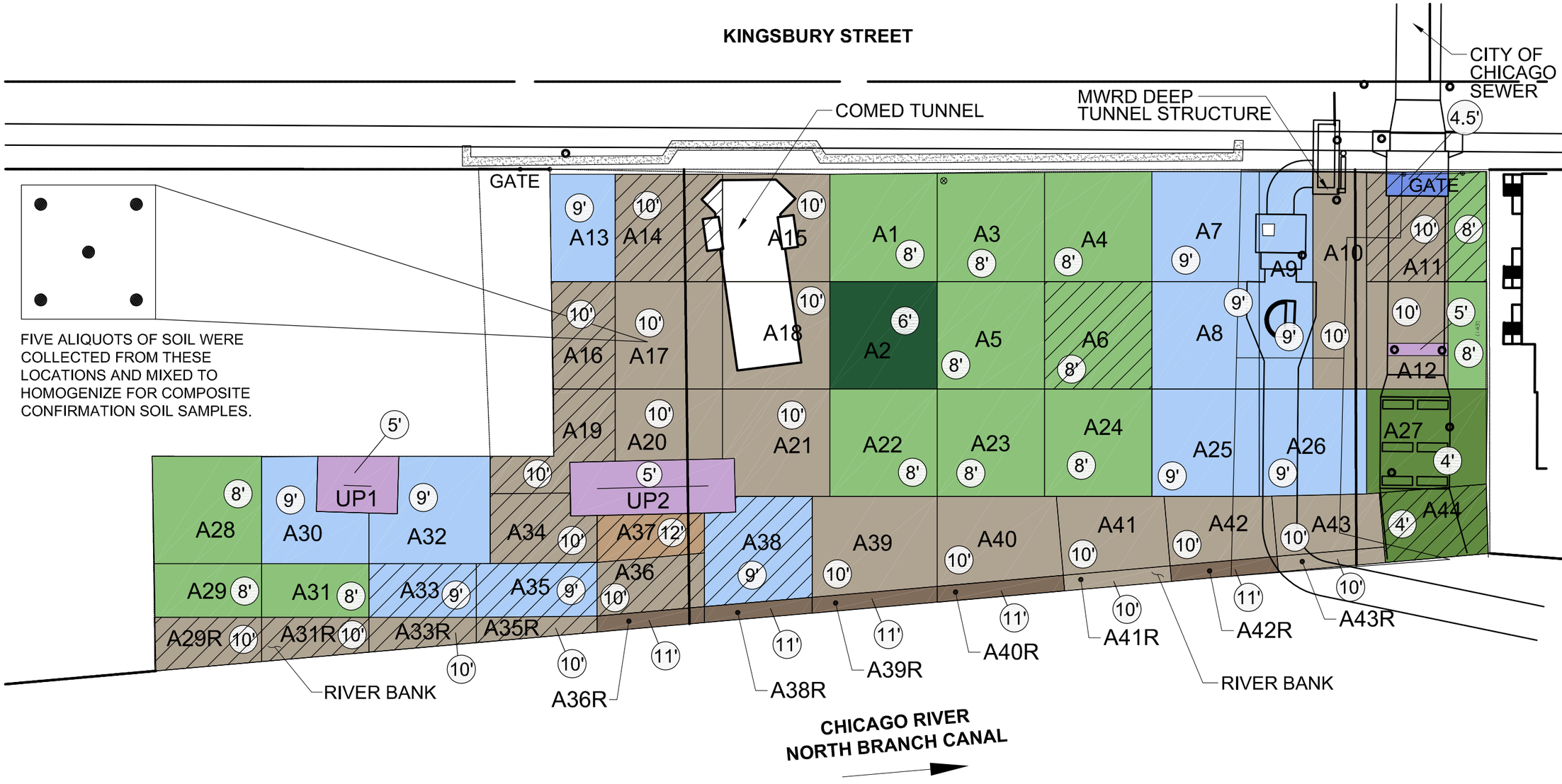
NATURAL RESOURCE TECHNOLOGY

DRAWN BY: RLH 08/01/11 APP'D BY: RJK DATE: 08/01/11

PROJECT NO. 2034/4.0

DRAWING NO. FIG–6

FIGURE NO. 6



CONFIRMATION SAMPLE LOCATION MAP

LASALLE CHESTNUT PARCEL
NORTH STATION
CHICAGO, ILLINOIS

DRAWN BY: RLH	CHECKED BY: RJK	APPROVED BY: SLM
DATE: 06/13/11	DATE: 06/13/11	DATE: 08/25/11

DRAWING NO: FIG–7
REFERENCE:.

CONFIRMATION SAMPLES EXCEED RESIDENTIAL SOIL SCREENING LEVELS FOR PAHs (POLYCYCLIC AROMATIC HYDROCARBON)

CONTAINMENT WALL

EXCAVATED TO DEPTH OF 4 FEET

EXCAVATED TO DEPTH OF 4.5 FEET

EXCAVATED TO DEPTH OF 5 FEET

EXCAVATED TO DEPTH OF 6 FEET

EXCAVATED TO DEPTH OF 8 FEET

EXCAVATED TO DEPTH OF 9 FEET

EXCAVATED TO DEPTH OF 10 FEET

EXCAVATED TO DEPTH OF 11 FEET

EXCAVATED TO DEPTH OF 12 FEET

NOTES:
1. AT THE REQUEST OF THE PROPERTY OWNER, FLOOR CONFIRMATION SOIL SAMPLES WERE COLLECTED IN EACH EXCAVATION GRID AREA. SIDE WALL SAMPLES WERE COLLECTED IN AREAS ALONG PROPERTY BOUNDARIES AND IN AREAS WHERE EXISTING UTILITIES LIMITED DEPTH OF EXCAVATION.

2. SCREENING LEVELS (SL) ARE PRIMARILY BASED ON USEPA REGIONAL SCREENING LEVELS (RSL) AND TAKEN FROM THE HIERARCHY OF SLS DEVELOPED FOR THE INTEGRYS BUSINESS SUPPORT LLC MANUFACTURED GAS PLANT SITES IN THE MULTI-SITE PROGRAM (EXPONENT, *RISK-ASSESSMENT FRAMEWORK ADDENDUM,* APRIL 2011).

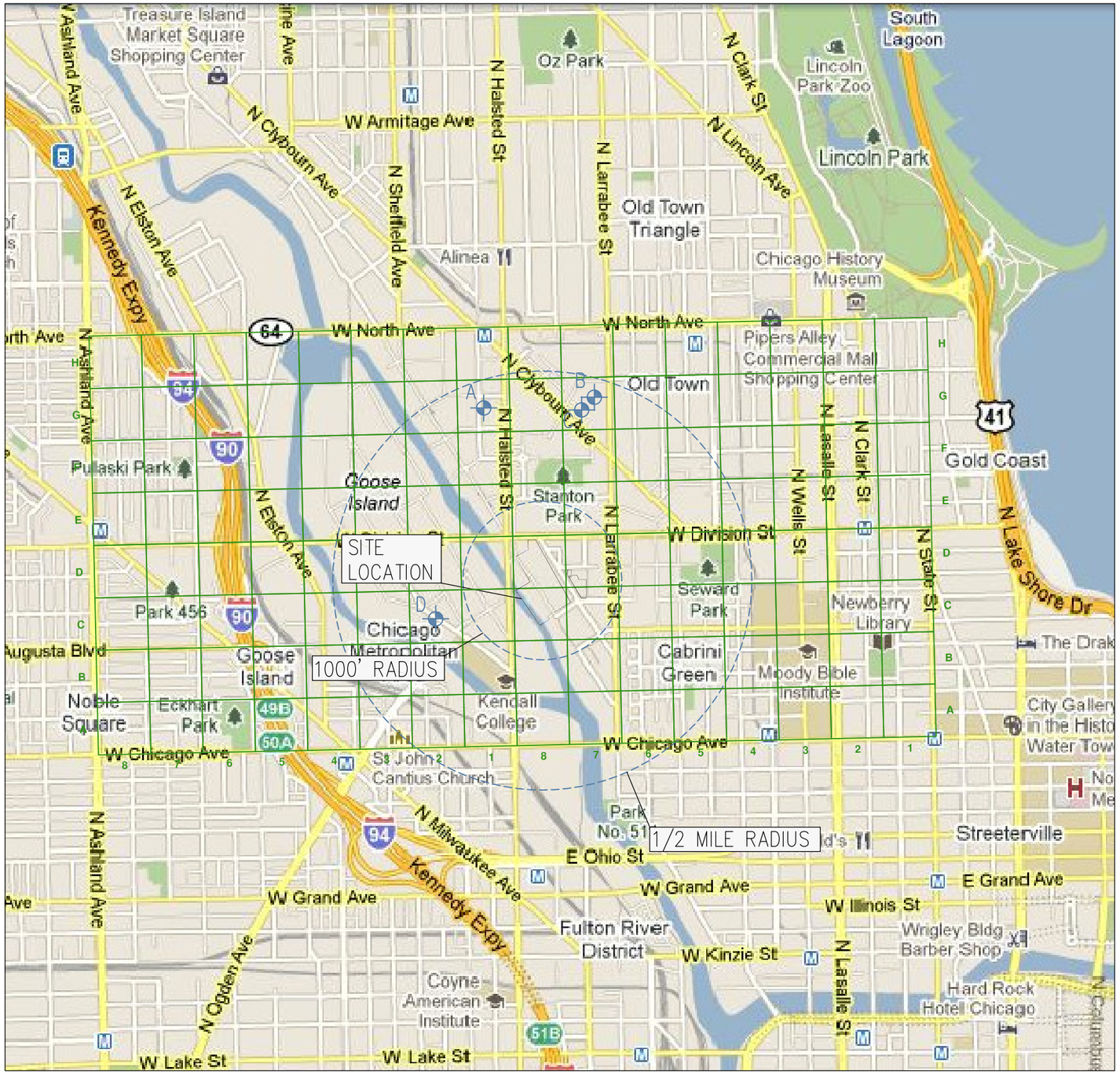
0 20 40
SCALE IN FEET

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "CONFIRMATION SAMPLE LOCATION–FIG 6.dwg" BY BURNS & MC DONNELL, DATED 2007.

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
7



LEGEND

APPROXIMATE WELL LOCATION

WELL LOCATION	WELL ID	OWNER
A	33853	PRIMA PRODUCTS
B	33829	CRYSTAL ICE CO.
C	33882	SIEBEN BREWING
D	03122920	CHICAGO PAPERBOARD CORP.

NOTES:

1. INFORMATION OBTAINED FROM:

ILLINOIS STATE WATER SURVEY, ILLINOIS STATE GEOLOGICAL SURVEY, ILLINOIS DEPARTMENT OF PUBLIC HEALTH, CITY OF CHICAGO DEPARTMENT OF PUBLIC HEALTH, COOK COUNTY DEPARTMENT OF PUBLIC HEALTH, CITY OF CHICAGO-DEPARTMENT OF WATER QUALITY AND ILLINOIS EPA-BUREAU OF WATER (2005).

N

0 750 1500

APPROXIMATE SCALE IN FEET

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "WELL LOCATION.dwg" BY BURNS & MC DONNELL, DATED 2005.

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CHECKED BY: RJK DATE: 08/05/11
APPROVED BY: JMK DATE: 08/05/11
DRAWING NO: FIG-8
REFERENCE: .

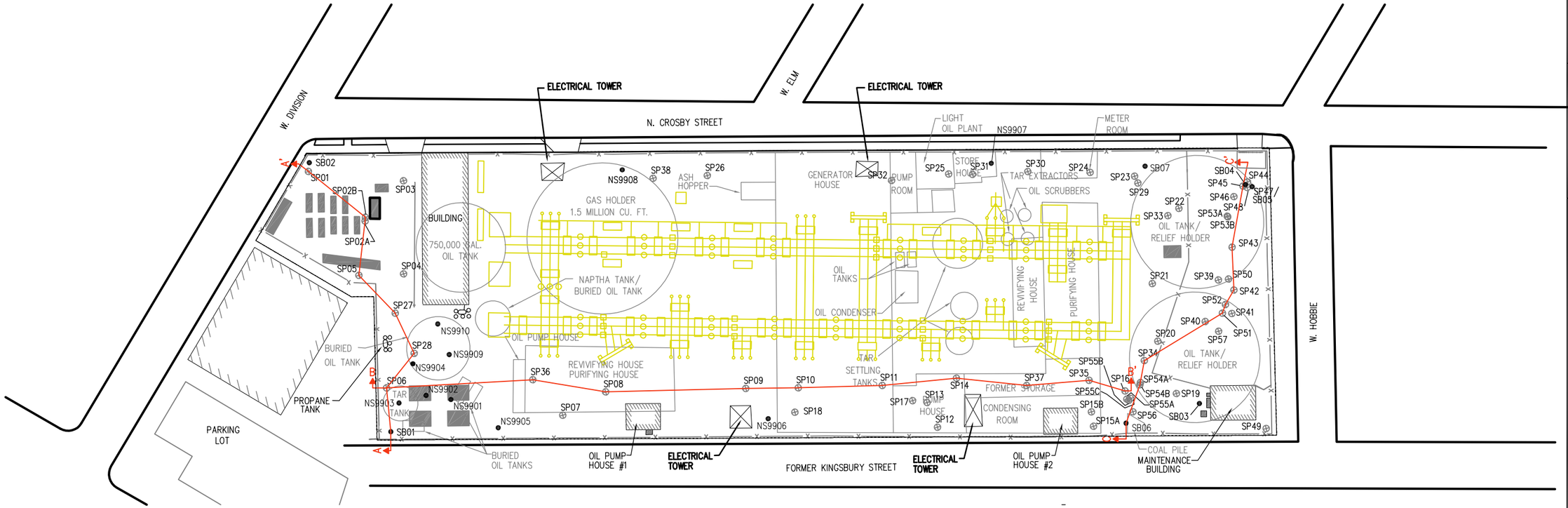
PRIVATE WELL LOCATION MAP

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
8



PROPERTY LINE
FENCE
HISTORICAL FEATURES
EXISTING COMED BUS STRUCTURE
EXISTING BUILDING
SOIL PROBE LOCATION
SOIL BORING LOCATION
A A' CROSS SECTION LOCATION
EXISTING ELECTRICAL STRUCTURES

NOTES:

1. COMED BUS STRUCTURE SCANNED FROM COMED "PLAN OF PROPERTY & EQUIPMENT ULTIMATE" CREATED 09/24/63 REVISED 07/30/99, NOT TO SCALE
2. HISTORIC FEATURE LOCATIONS ARE APPROXIMATED.

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "XSECTION LOC-SVY.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

N

0 50 100
SCALE IN FEET

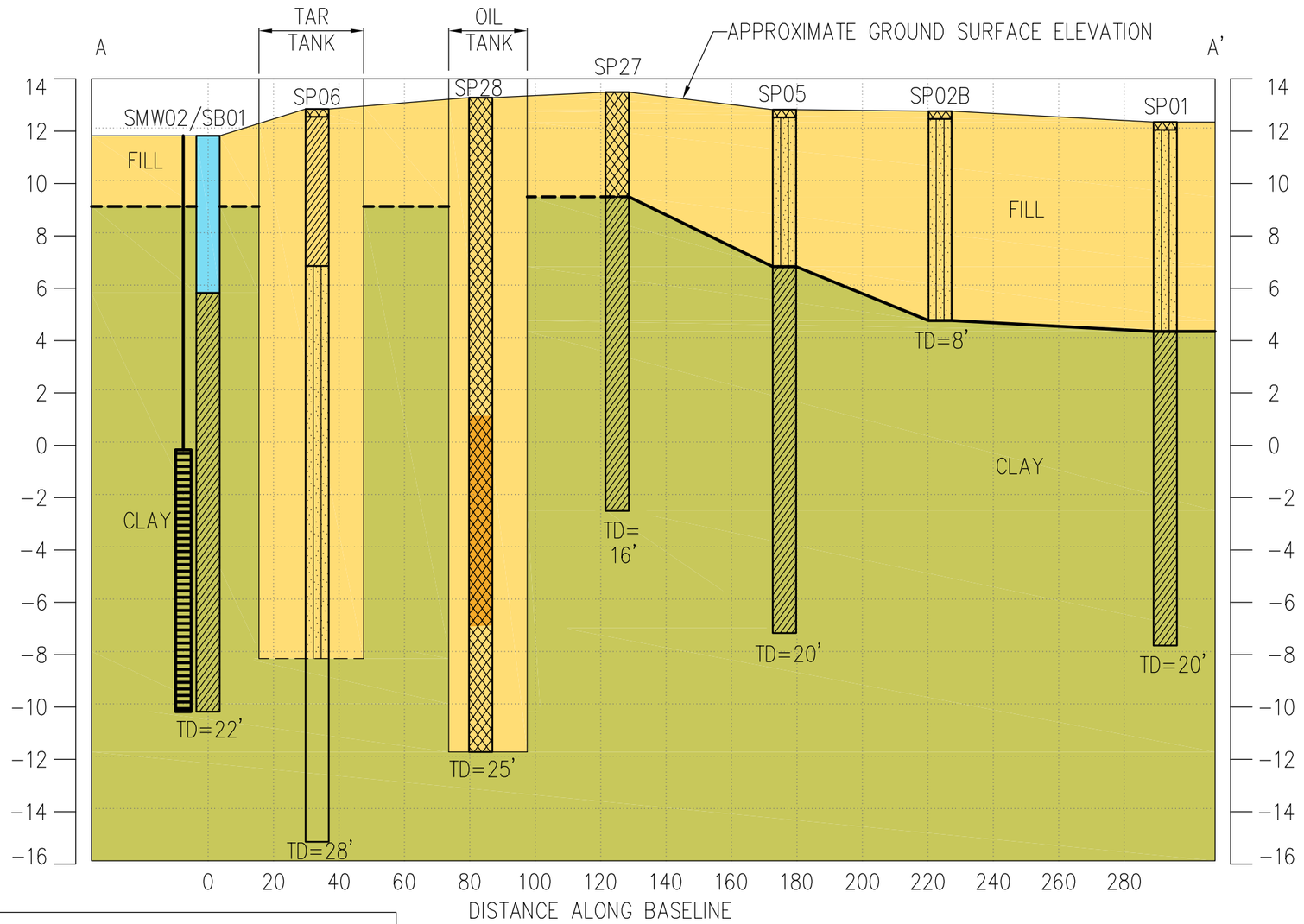
DRAWN BY: RLH DATE: 06/01/11
CHECKED BY: RJK DATE: 06/01/11
APPROVED BY: SLM DATE: 08/26/11
DRAWING NO: FIG-9
REFERENCE: .

GEOLOGIC CROSS SECTION LOCATIONS
ComEd PARCEL
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 2034/5

FIGURE NO. 9



MISCELLANEOUS FILL*
SILTY SAND
CLAY
PRESUMED LITHOLOGY DEPTH
SCREEN LENGTH

FILL
CLAY
DATA NOT AVAILABLE **
COAL TAR

5 0 5 10
VERTICAL SCALE IN FEET

40 0 40 80
HORIZONTAL SCALE IN FEET

NOTE:

* SEE CORRESPONDING BORING LOGS FOR SPECIFIC DESCRIPTION.

** BLIND ADVANCEMENT–SOIL REMOVED USING AIRKNIFE TO VERIFY IF UNDERGROUND UTILITIES PRESENT.

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "XSECTION AA.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.
VERTICAL DATUM NOT CONFIRMED, ASSUMED TO BE CHICAGO CITY DATUM.

GEOLOGIC CROSS SECTION A–A'
ComEd PARCEL
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

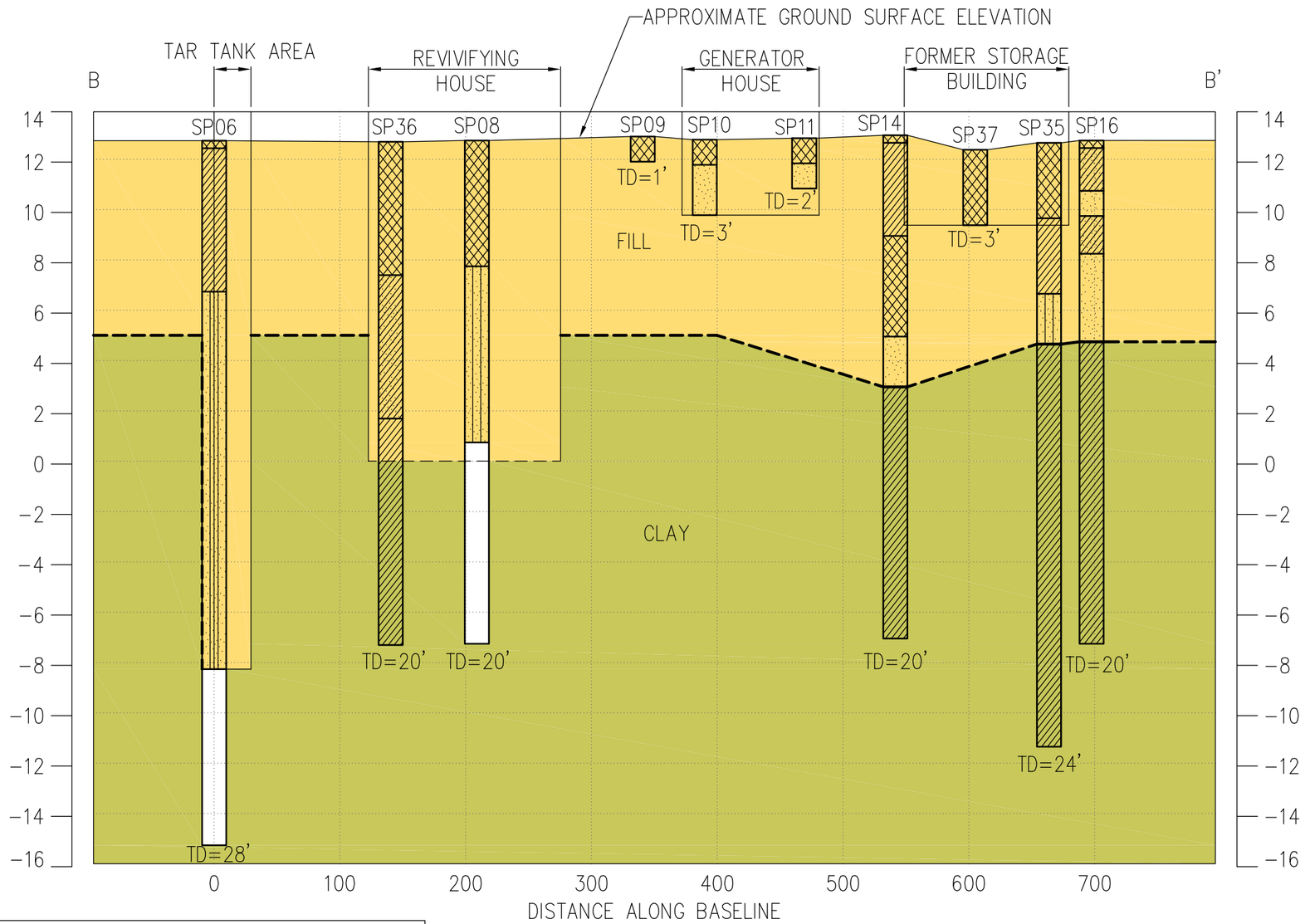
DRAWN BY: SJD/RLH	CHECKED BY: RJK	APPROVED BY: SLM
DATE: 05/31/11	DATE: 06/01/11	DATE: 08/30/11

DRAWING NO: FIG–10
REFERENCE: .

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
10



MISCELLANEOUS FILL*
SAND
SILTY SAND
CLAY
CLAY WITH SAND
FILL
CLAY
NO RECOVERY
PRESUMED LITHOLOGY DEPTH

NOTE:
* SEE CORRESPONDING BORING LOGS FOR SPECIFIC DESCRIPTION.

5 0 5 10
VERTICAL SCALE IN FEET

100 0 100 200
HORIZONTAL SCALE IN FEET

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "XSECTION-BB.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.
VERTICAL DATUM NOT CONFIRMED, ASSUMED TO BE CHICAGO CITY DATUM.

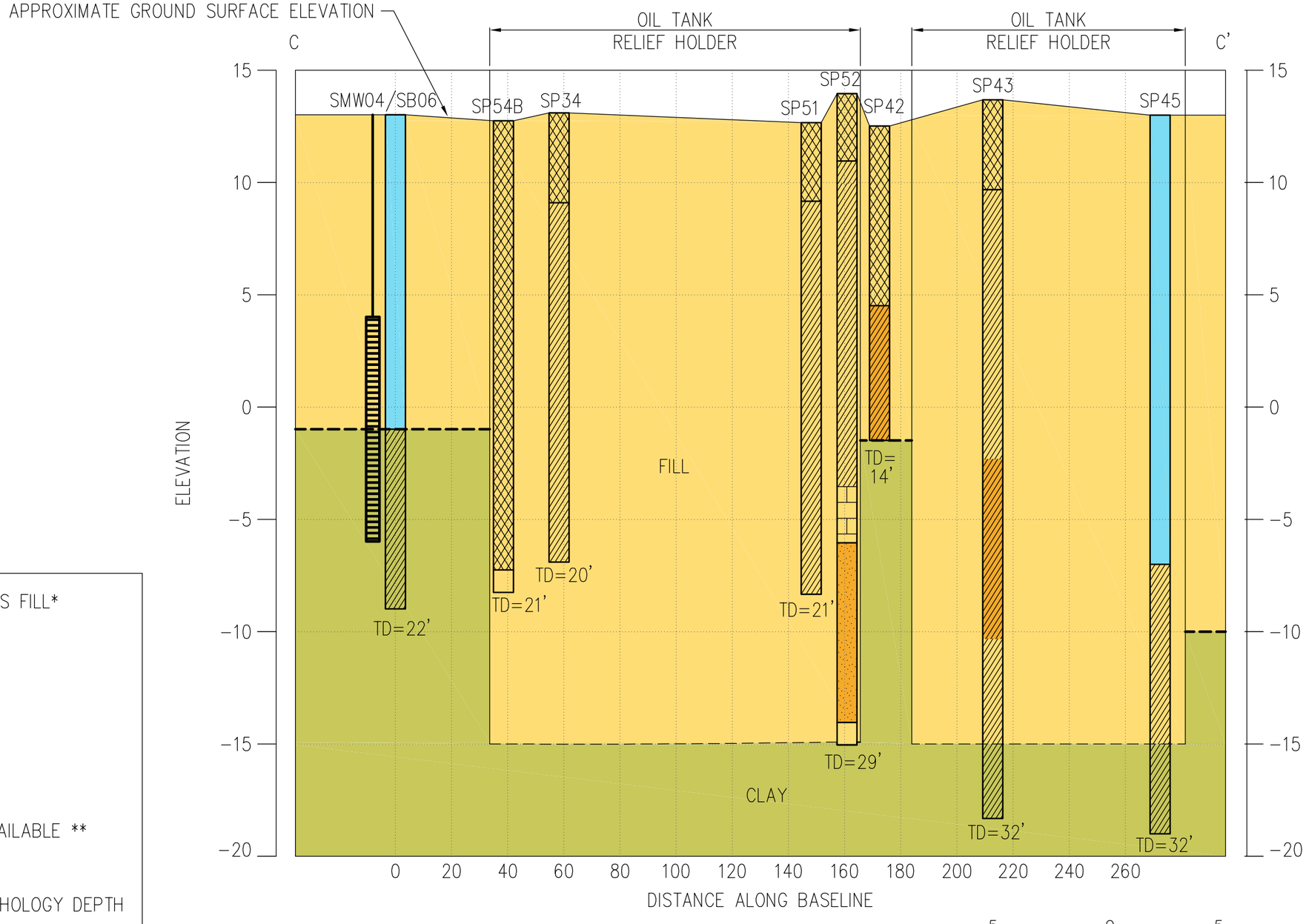
GEOLOGIC CROSS SECTION B-B'
ComEd PARCEL
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

DRAWN BY: SJD/RLH DATE: 05/31/11
CHECKED BY: RJK DATE: 06/01/11
APPROVED BY: SLM DATE: 08/30/11
DRAWING NO: FIG-11
REFERENCE: .

NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 2034/5

FIGURE NO. 11



- MISCELLANEOUS FILL*
- SAND
- BRICK
- CLAY
- FILL
- CLAY
- DATA NOT AVAILABLE **
- COAL TAR
- PRESUMED LITHOLOGY DEPTH
- SCREEN LENGTH

NOTE:

* SEE CORRESPONDING BORING LOGS FOR SPECIFIC DESCRIPTION.

** BLIND ADVANCEMENT– NO SAMPLE COLLECTED.

5 0 5 10
VERTICAL SCALE IN FEET

40 0 40 80
HORIZONTAL SCALE IN FEET

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "XSECTION-CC.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.
VERTICAL DATUM NOT CONFIRMED, ASSUMED TO BE CHICAGO CITY DATUM.

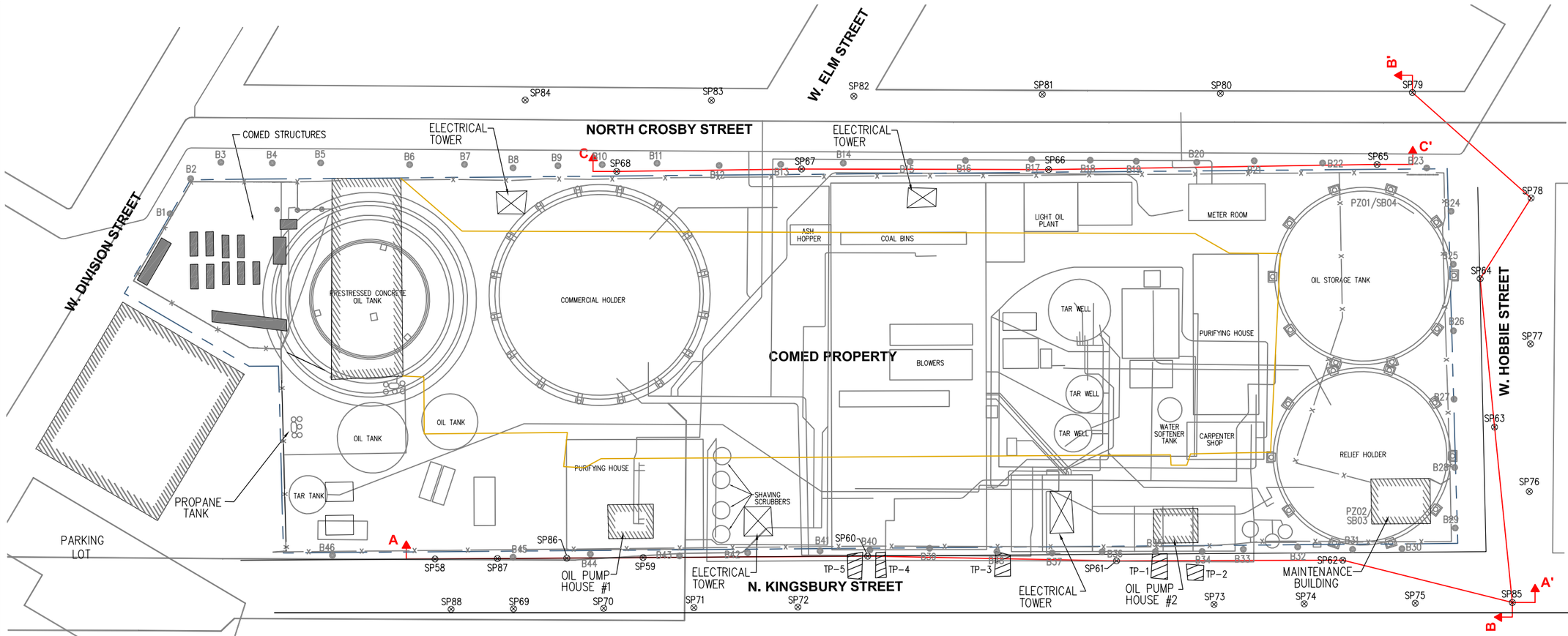
DRAWN BY: RLH DATE: 05/31/11
CHECKED BY: RJK DATE: 06/01/11
APPROVED BY: SLM DATE: 08/30/11
DRAWING NO: FIG-12
REFERENCE:.

GEOLOGIC CROSS SECTION C-C'
ComEd PARCEL
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 2034/5

FIGURE NO. 12



- PROPERTY BOUNDARY
- HISTORICAL STRUCTURES
- EXISTING COMED STRUCTURES
- BUS STRUCTURE OUTLINE
- FENCELINE
- SOIL BORING LOCATION
- SOIL PROBE LOCATION
- TEST PIT LOCAITON
- A — A' GEOLOGIC CROSS-SECTION LOCATION
- ROW RIGHT OF WAY
- EXISTING BUILDING

0 40 80
SCALE IN FEET

NOTE:
HISTORIC FEATURE LOCATIONS ARE APPROXIMATED.

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "XSECTION LOC.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

DRAWN BY: SJD/RLH DATE: 05/31/11
CHECKED BY: RJK DATE: 06/01/11
APPROVED BY: SLM DATE: 08/26/11
DRAWING NO: FIG-13
REFERENCE: .

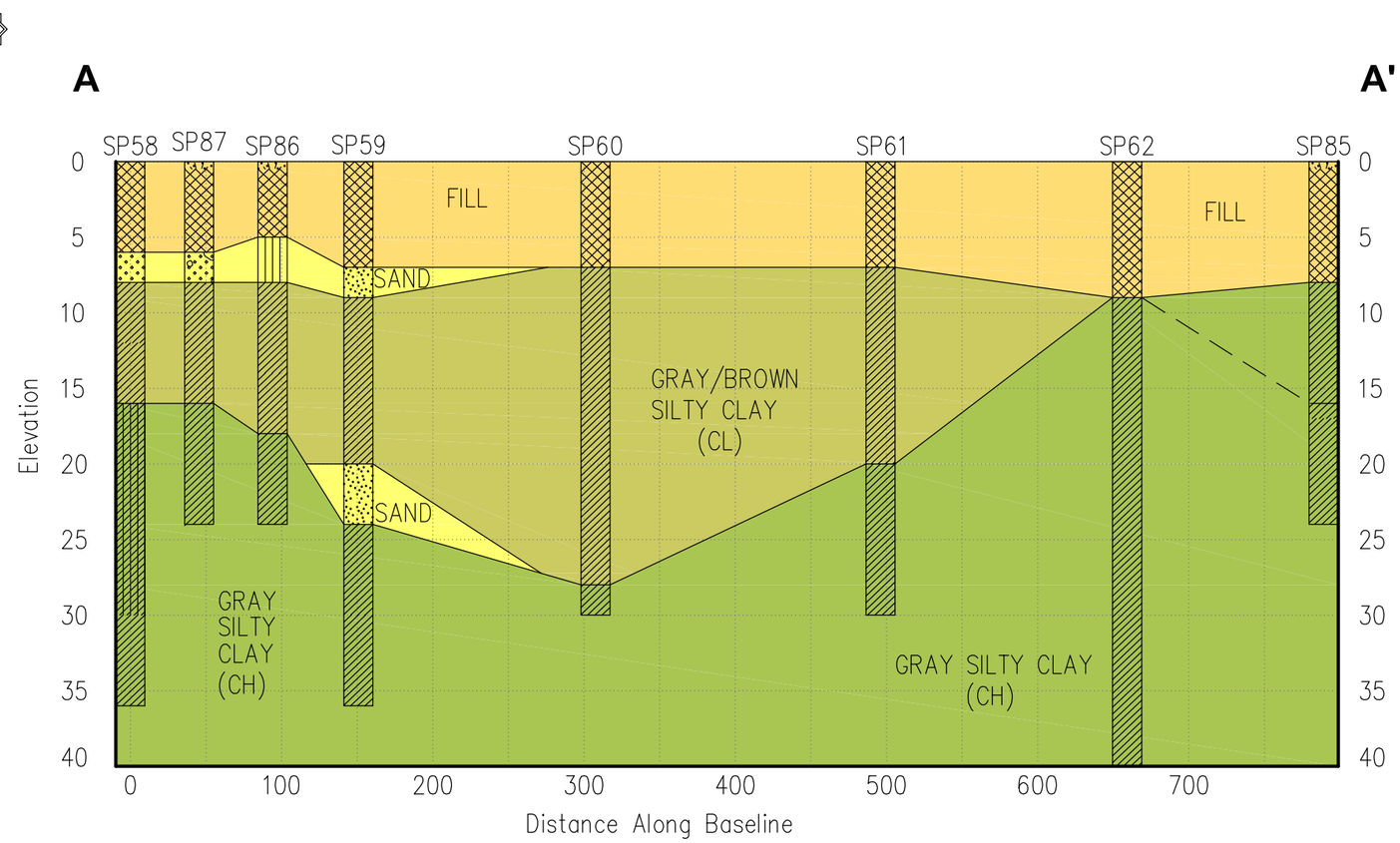
GEOLOGIC CROSS SECTION LOCATIONS CITY ROWs

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
13



FILL
SAND
GRAY/BROWN SILTY CLAY
GRAY SILTY CLAY
FILL

SAND
CLAY
INFERRED CONTACT
CH HIGH PLASTICITY
CL LOW PLASTICITY
ROW RIGHT OF WAY

10 0 10 20
VERTICAL SCALE IN FEET

100 0 100 200
HORIZONTAL SCALE IN FEET

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "XSECTION A-A'.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.
VERTICAL DATUM NOT CONFIRMED, ASSUMED TO BE CHICAGO CITY DATUM.

CROSS SECTION A-A'
CITY ROWs
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

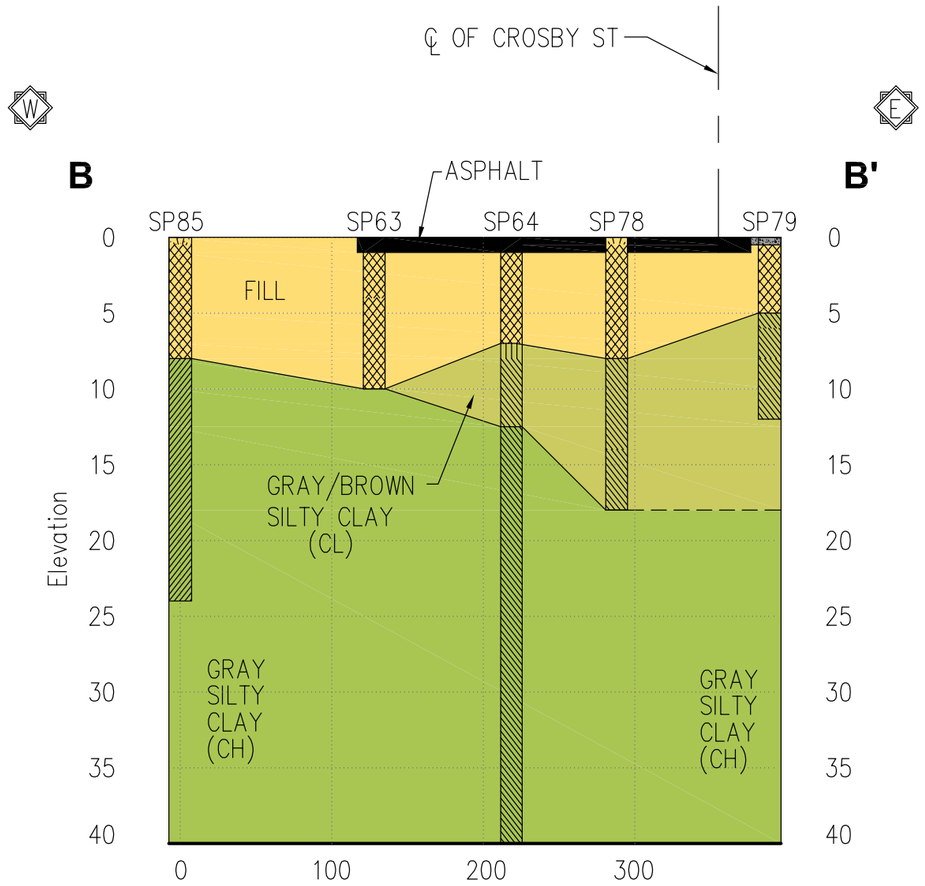
DRAWN BY:	RLH	DATE: 05/31/11
CHECKED BY:	RJK	DATE: 06/01/11
APPROVED BY:	SLM	DATE: 08/30/11

DRAWING NO: FIG-14
REFERENCE:.

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
14



	ASPHALT		SILT
	CONCRETE		CLAY
	FILL	— — —	INFERRED CONTACT
	GRAY/BROWN SILTY CLAY	CH	HIGH PLASTICITY
	GRAY SILTY CLAY	CL	LOW PLASTICITY
	FILL	ROW	RIGHT OF WAY

10 0 10 20
VERTICAL SCALE IN FEET

100 0 100 200
HORIZONTAL SCALE IN FEET

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "XSECTION B–B'.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.
VERTICAL DATUM NOT CONFIRMED, ASSUMED TO BE CHICAGO CITY DATUM.

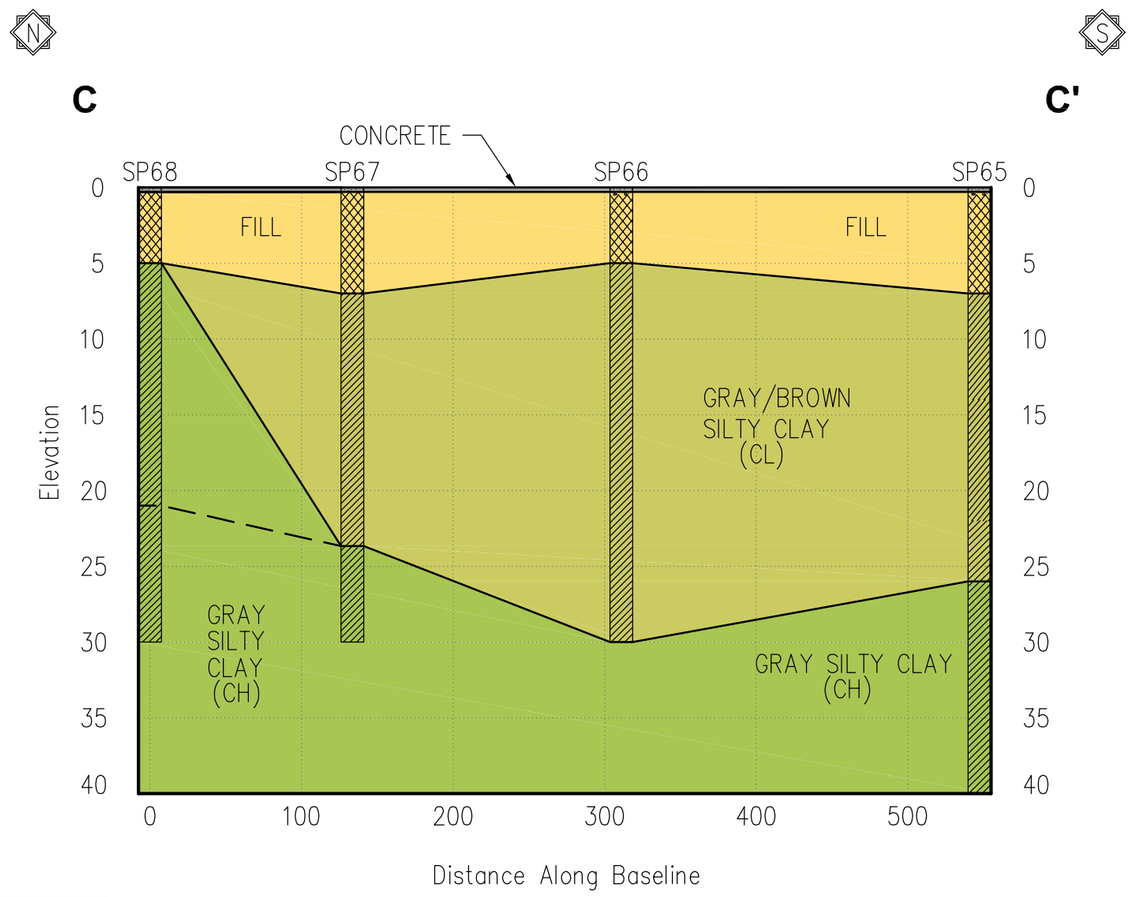
DRAWN BY: RLH DATE: 06/01/11
CHECKED BY: RJK DATE: 06/01/11
APPROVED BY: SLM DATE: 08/30/11
DRAWING NO: FIG–15
REFERENCE:.

CROSS SECTION B–B'
CITY ROWs
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
15



CONCRETE

FILL

GRAY/BROWN SILTY CLAY

GRAY SILTY CLAY

FILL

CLAY

INFERRED CONTACT

CH HIGH PLASTICITY

CL LOW PLASTICITY

ROW RIGHT OF WAY

10 0 10 20

VERTICAL SCALE IN FEET

100 0 100 200

HORIZONTAL SCALE IN FEET

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "XSECTION C–C'.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.
VERTICAL DATUM NOT CONFIRMED, ASSUMED TO BE CHICAGO CITY DATUM.

DRAWN BY: RLH DATE: 06/01/01
CHECKED BY: RJK DATE: 06/01/11
APPROVED BY: SLM DATE: 08/30/11
DRAWING NO: FIG–16
REFERENCE:.

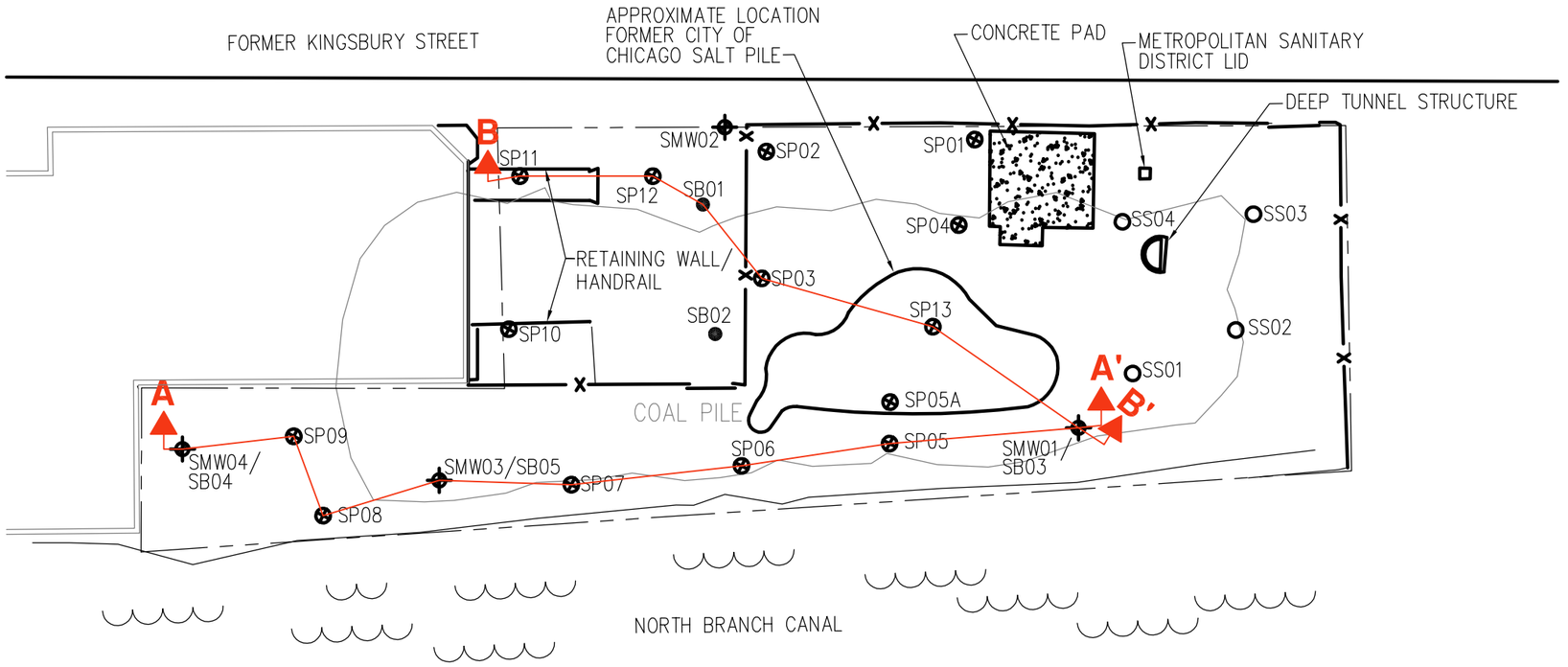
CROSS SECTION C–C'
CITY ROWs

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
16



PROPERTY BOUNDARY

FENCE

HISTORICAL FEATURES

SHORELINE

SOIL PROBE LOCATION

SOIL BORING LOCATION

SURFACE SAMPLE SOIL LOCATION

MONITORING WELL LOCATION

A A' CROSS SECTION LOCATION

0 30 60

SCALE IN FEET

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "XSECTION LOC-SVY.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

DRAWN BY: RLH DATE: 06/01/11

CHECKED BY: RJK DATE: 06/01/11

APPROVED BY: SLM DATE: 08/25/11

DRAWING NO: FIG-17

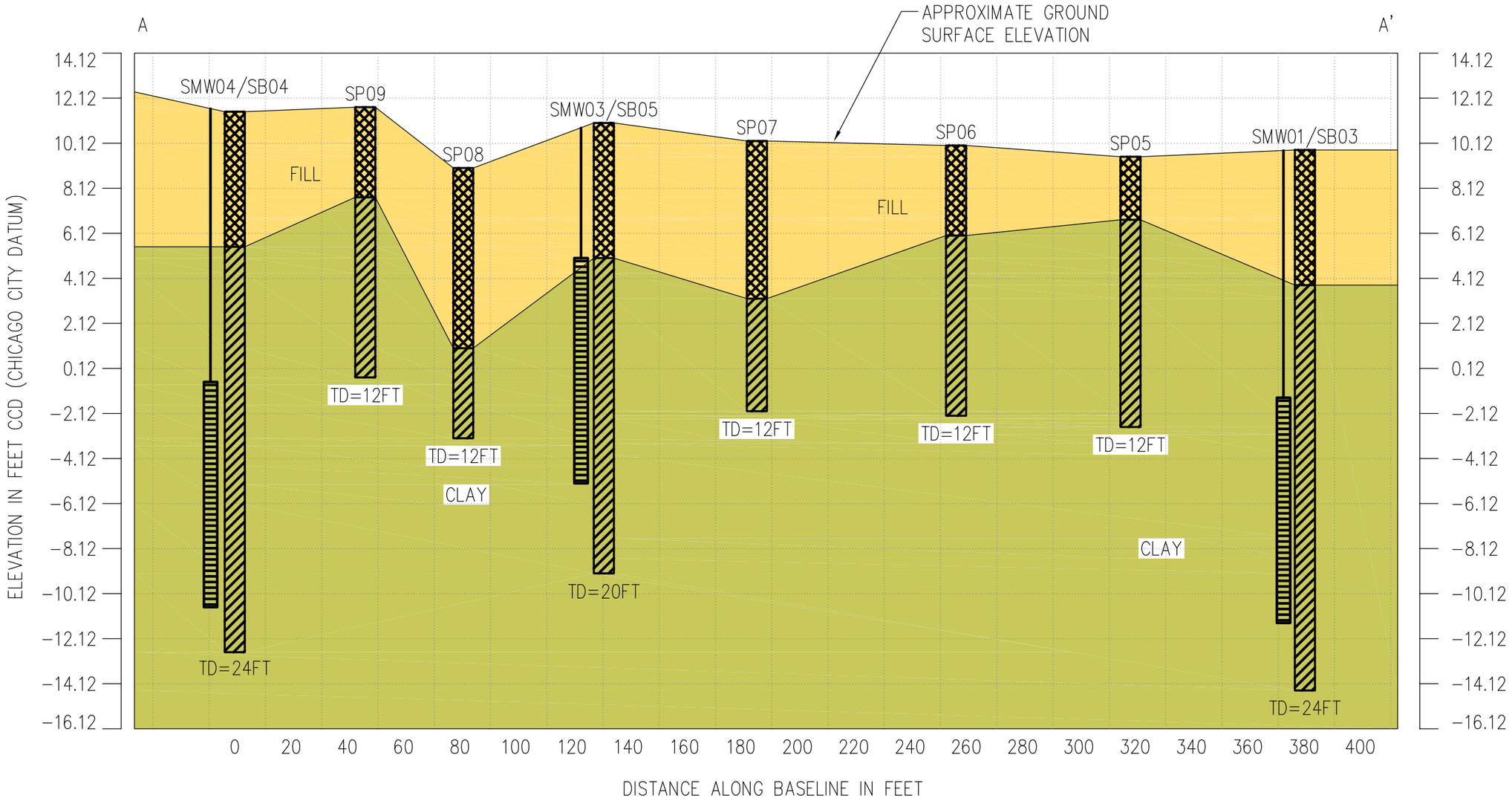
REFERENCE:.

GEOLOGIC CROSS SECTION LOCATIONS
LASALLE CHESTNUT PARCEL
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
17



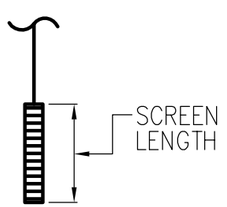
FILL – CONSISTS PRIMARILY OF GRAVEL, SAND & CRUSHED ASPHALT WITH SMALLER AMOUNTS OF SILT, CLAY, CRUSHED BRICKS, CINDERS & WOOD.

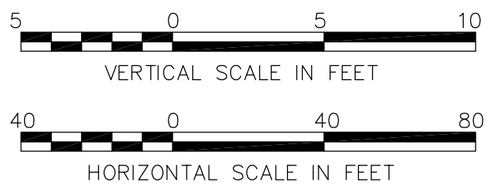
CLAY – NATIVE MATERIAL CONSISTING OF BROWN TO BROWN/GRAY SANDY TO SILTY CLAY.

FILL

CLAY

TD = TOTAL DEPTH





SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "XSECTION-AA.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

GEOLOGIC CROSS SECTION A-A'
LASALLE CHESTNUT PARCEL

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

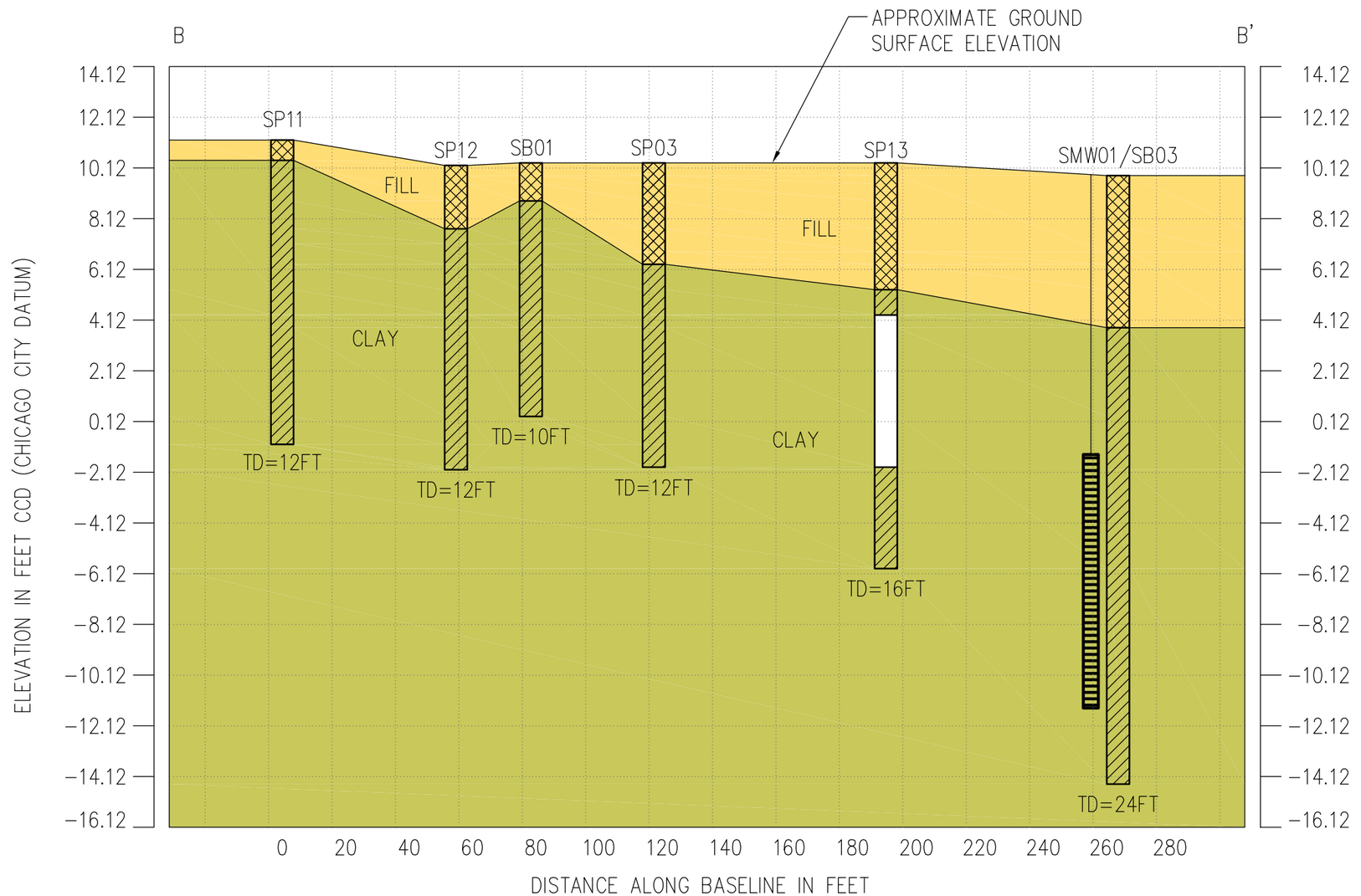
DRAWN BY: RLH	CHECKED BY: RJK	APPROVED BY: JMK
DATE: 06/01/11	DATE: 06/01/11	DATE: 06/13/11

DRAWING NO: FIG-18
REFERENCE:.

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
18



FILL – CONSISTS PRIMARILY OF GRAVEL, SAND, & CRUSHED ASPHALT WITH SMALLER AMOUNTS OF SILT, CLAY, CRUSHED BRICKS, CINDERS, & WOOD.

CLAY – NATIVE MATERIAL CONSISTING OF BROWN TO BROWN/GRAY SANDY TO SILTY CLAY.

FILL

CLAY

NO RECOVERY

TD = TOTAL DEPTH

SCREEN LENGTH

5 0 5 10

VERTICAL SCALE IN FEET

40 0 40 80

HORIZONTAL SCALE IN FEET

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "XSECTION-BB.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

DRAWN BY: RLH DATE: 06/01/11
CHECKED BY: RJK DATE: 06/01/11
APPROVED BY: JMK DATE: 06/13/11
DRAWING NO: FIG-19
REFERENCE:.

GEOLOGIC CROSS SECTION B-B'
LASALLE CHESTNUT PARCEL
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
19

NATURAL RESOURCE TECHNOLOGY

FILL THICKNESS CONTOURS
SITE SPECIFIC WORK PLAN
NORH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

0 25 50 75
SCALE IN FEET

NOTE: HISTORIC FEATURE LOCATIONS ARE APPROXIMATED

FILL THICKNESS CONTOURS (2-FT INTERVAL)
SOIL BORING LOCATION
NORTH STATION OU BOUNDARY
RIVER
HISTORICAL SITE FEATURES

DEPTH OF EXCAVATION/BACKFILL (IN FEET)

[4] [5] [6] [8] [9] [10] [11] [12]

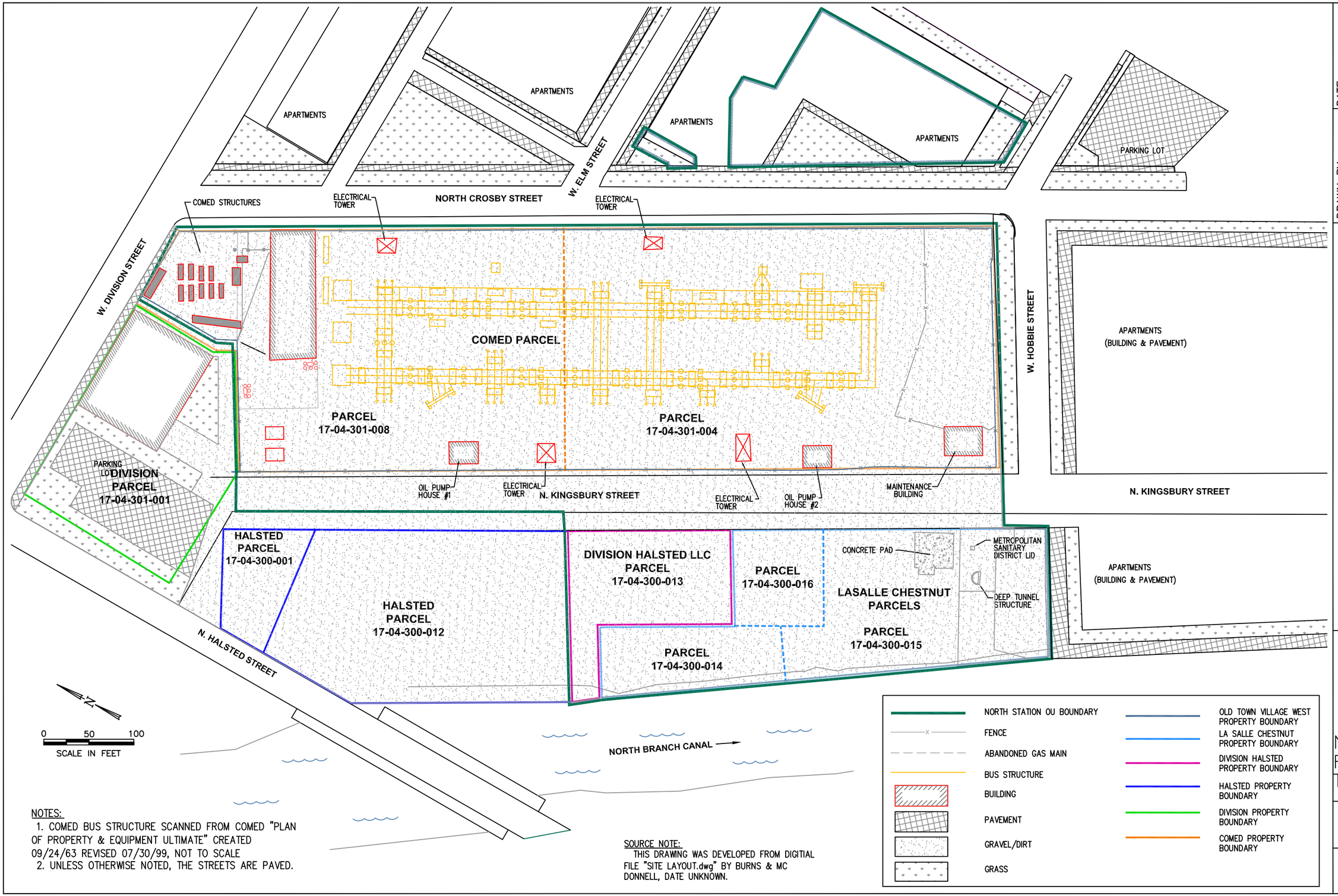
PROJECT NO: 2034/5.0

FIGURE NO: 20

DRAWN BY/DATE:	TDC	8/2/11
CHECKED BY/DATE:	RJK	8/2/11
APPROVED BY/DATE:	RJK	8/29/11

SITE GROUNDCOVER MAP

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS



NOTES:
1. COMED BUS STRUCTURE SCANNED FROM COMED "PLAN OF PROPERTY & EQUIPMENT ULTIMATE" CREATED 09/24/63 REVISED 07/30/99, NOT TO SCALE
2. UNLESS OTHERWISE NOTED, THE STREETS ARE PAVED.

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "SITE LAYOUT.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

DRAWN BY:	RLH	DATE: 08/05/11
CHECKED BY:	SLM	DATE: 08/05/11
APPROVED BY:	SLM	DATE: 08/05/11
DRAWING NO: FIG-21		
REFERENCE:.		

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
21

NATURAL RESOURCE TECHNOLOGY

TOP OF CLAY SURFACE ELEVATIONS
SITE SPECIFIC WORK PLAN
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

0 25 50 75
SCALE IN FEET

NOTE: HISTORIC FEATURE LOCATIONS ARE APPROXIMATED
VERTICAL DATUM REFERENCE IS THE CHICAGO CITY DATUM

CLAY ELEVATION CONTOURS (2-FOOT INTERVAL)
SOIL BORING LOCATION
NORTH STATION OU BOUNDARY
RIVER
HISTORICAL SITE FEATURES

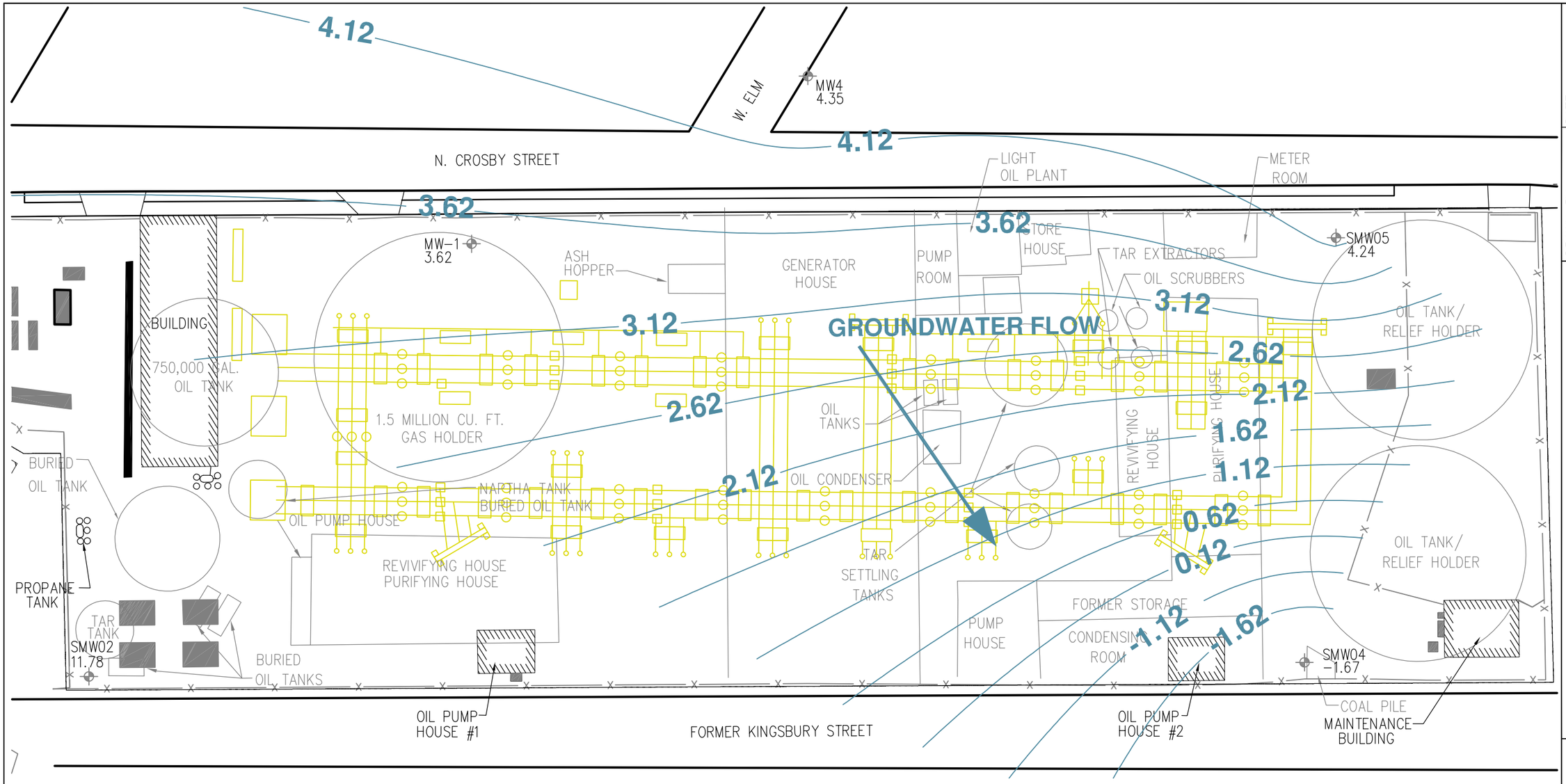
CLAY SURFACE ELEVATION (IN FEET)

-4 -3 -2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5.5 6.5 7 7.5 8

PROJECT NO: 2034/5.0

FIGURE NO: 22

DRAWN BY/DATE:	TDC	8/2/11
CHECKED BY/DATE:	RJK	8/2/11
APPROVED BY/DATE:	RJK	8/29/11



PROPERTY LINE
FENCE
HISTORICAL FEATURES
COMED BUS STRUCTURE
2.62 GROUNDWATER CONTOUR(CCD)
BUILDING
ELECTRICAL STRUCTURES

NOTES:

1. ELEVATIONS ACCORDING TO CHICAGO CITY DATUM (CCD).
2. COMED BUS STRUCTURE SCANNED FROM COMED "PLAN OF PROPERTY & EQUIPMENT ULTIMATE" CREATED 09/24/63 REVISED 07/30/99, NOT TO SCALE.
3. HISTORIC FEATURE LOCATIONS ARE APPROXIMATED.

N

0 30 60
SCALE IN FEET

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "GND WTR CONT-SVY.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

DRAWN BY: RLH	DATE: 08/03/11	
CHECKED BY: RJK	DATE: 08/03/11	
APPROVED BY: JMK	DATE: 08/26/11	
DRAWING NO: FIG-23		
REFERENCE:.		

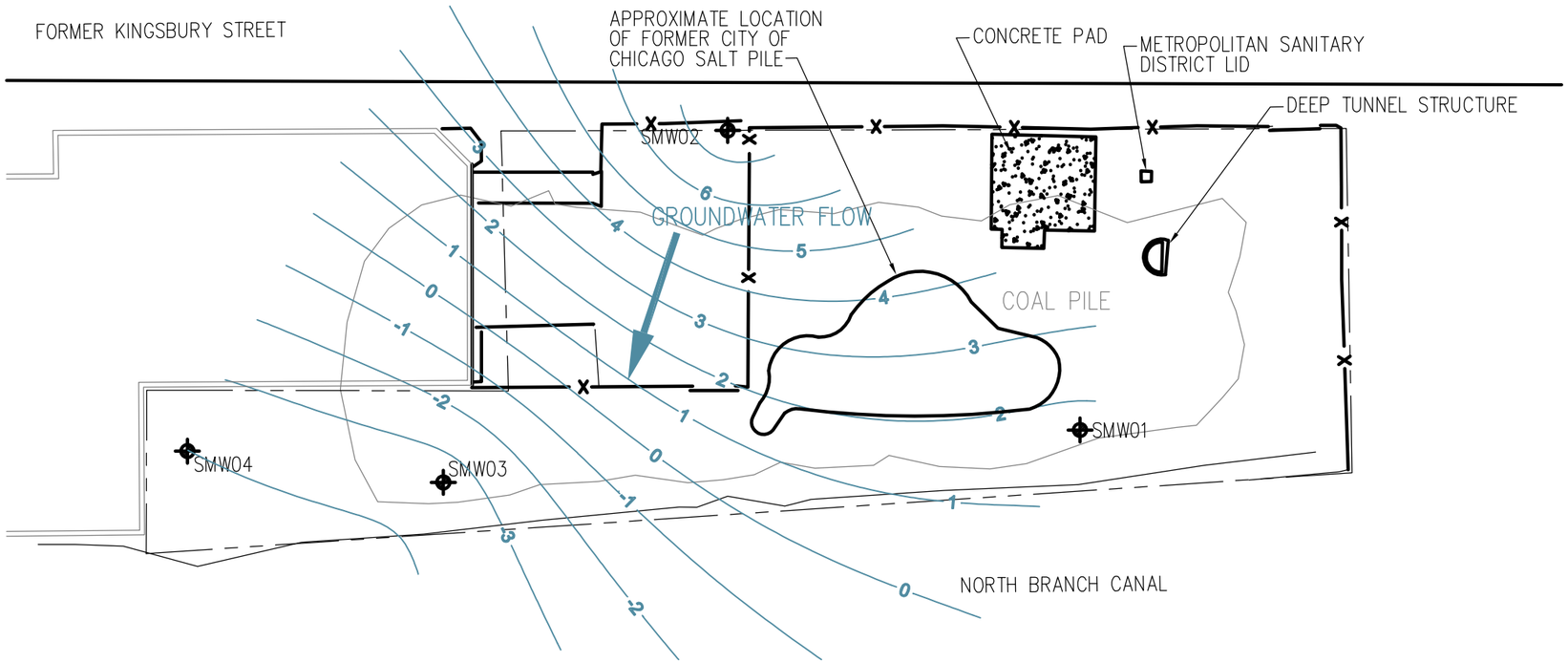
GROUNDWATER CONTOUR MAP ComEd PARCEL

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
23



PROPERTY LINE

2 GROUNDWATER CONTOUR (FEET, CHICAGO CITY DATUM)

FENCE

HISTORICAL FEATURES

SHORELINE

FOOTPRINT OF FORMER BUILDING

MONITORING WELL LOCATION

0 30 60

SCALE IN FEET

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "GND WTR CONTOUR-SVY.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

DRAWN BY:	RLH	DATE: 08/03/11
CHECKED BY:	RJK	DATE: 08/03/11
APPROVED BY:	JMK	DATE: 08/03/11

DRAWING NO: FIG-24
REFERENCE:.

GROUNDWATER CONTOUR MAP
LASALLE CHESTNUT PARCEL

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

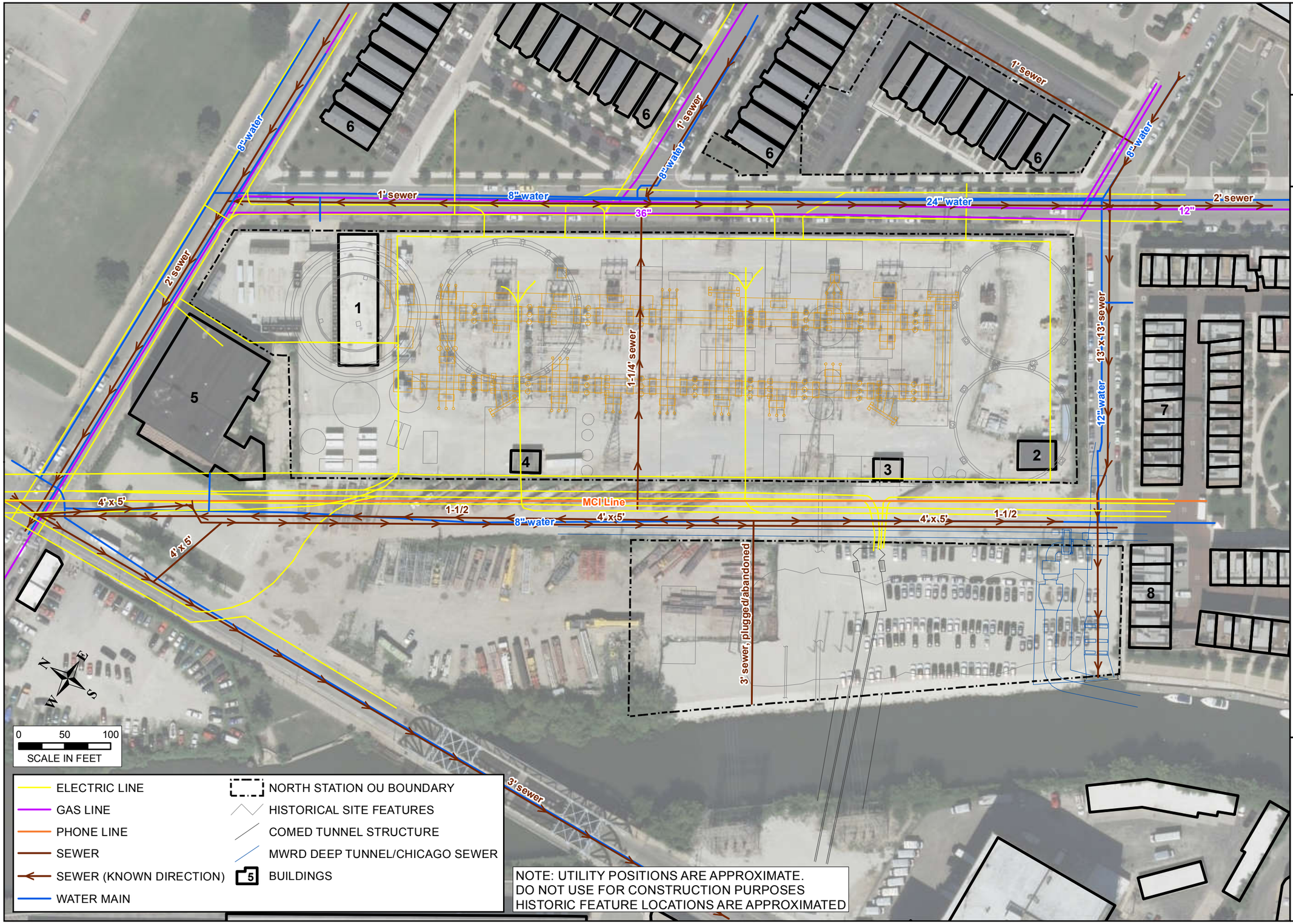
PROJECT NO.
2034/5

FIGURE NO.
24

NATURAL RESOURCE TECHNOLOGY

UTILITY INFRASTRUCTURE LOCATIONS

SITE SPECIFIC WORK PLAN
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS



- ELECTRIC LINE
- GAS LINE
- PHONE LINE
- SEWER
- SEWER (KNOWN DIRECTION)
- WATER MAIN
- NORTH STATION OU BOUNDARY
- HISTORICAL SITE FEATURES
- COMED TUNNEL STRUCTURE
- MWRD DEEP TUNNEL/CHICAGO SEWER
- 5 BUILDINGS

NOTE: UTILITY POSITIONS ARE APPROXIMATE.
DO NOT USE FOR CONSTRUCTION PURPOSES
HISTORIC FEATURE LOCATIONS ARE APPROXIMATED

PROJECT NO: 2034/5.0

FIGURE NO: 25

DRAWN BY/DATE:	TDC	8/3/11
CHECKED BY/DATE:	SLM	8/3/11
APPROVED BY/DATE:	SLM	8/24/11

NATURAL RESOURCE TECHNOLOGY

SOIL BORING LOCATIONS AND LOG OBSERVATIONS

SITE SPECIFIC WORK PLAN
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

PROJECT NO: 2034/5.1

FIGURE NO: 26

DRAWN BY/DATE:	TDC	11/2/11
CHECKED BY/DATE:	SLM	11/2/11
APPROVED BY/DATE:	SLM	11/2/11

NATURAL RESOURCE TECHNOLOGY

BENZENE EXCEEDANCES IN SOIL AND GROUNDWATER

SITE SPECIFIC WORK PLAN
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

N Crosby St

N Kingsbury St

W Hobbie St

ComED

DIVISION HALSTED

HALSTED

LASALLE CHESTNUT

SMW03: ND

SMW05: **19,000 µg/L**

PZ01: **11 µg/L**

SMW04: **15,000 µg/L**

PZ02: 1 µg/L

SMW02: 0.6 µg/L

SMW02: **68 µg/L**

SP-14: **75 µg/L**

SP-11: ND

SP-12: ND

SP-2: ND

B2: ND

SP-5: ND

PZ01: ND

SMW04: **16 µg/L**

SMW03: **71 µg/L**

SMW01: **26 µg/L**

MW-4: ND

MW-1: Tar

PZ03

0 25 50 75

SCALE IN FEET

NOTE: HISTORIC FEATURE LOCATIONS ARE APPROXIMATED

MONITORING WELL EXCEEDING SCREENING LEVEL

MONITORING WELL BELOW SCREENING LEVEL

SOIL BORING EXCEEDING SCREENING LEVEL

SOIL BORING BELOW SCREENING LEVEL

PROPERTY BOUNDARY

HISTORICAL SITE FEATURES

COMED TUNNEL STRUCTURE

MWRD DEEP TUNNEL/CHICAGO SEWER

BUILDINGS

BENZENE SCREENING VALUES
RESIDENTIAL SOIL = 1,100 µG/KG
RESIDENTIAL GROUNDWATER = 5 µG/L
µG/KG - MICROGRAMS PER KILOGRAM
µG/L - MICROGRAMS PER LITER

Screening levels (SL) are primarily based on USEPA Regional Screening Levels (RSL) and taken from the hierarchy of SLs developed for the Integrys Business Support LLC Manufactured Gas Plant sites in the multi-site program (Exponent, Risk-Assessment Framework Addendum, April 2011).

PROJECT NO: 2034/5.0

FIGURE NO: 27

DRAWN BY/DATE:	TDC	8/3/11
CHECKED BY/DATE:	SLM	8/3/11
APPROVED BY/DATE:	SLM	8/23/11

NATURAL RESOURCE TECHNOLOGY

NAPHTHALENE EXCEEDANCES IN SOIL AND GROUNDWATER

SITE SPECIFIC WORK PLAN NORTH STATION OPERABLE UNIT CHICAGO, ILLINOIS

N Crosby St

N Kingsbury St

W Hobbie St

ComED

DIVISION HALSTED

HALSTED

LASALLE CHESTNUT

SP84 SP83 MW-4: ND SP82 SP81 SP80 SP79

SP68 SP67 SP66 SMW05: 23 µg/L SP65

SMW03: ND SP01 SP03 MW-1: Tar NS9908 SP26 SP25 SP30 SB07 SP78

SP23 SP44 PZ01: ND SB05 SP29 SP22 SP33 SP64 SP43

SP05 SP04 SP21 SP39 SP77

SP27 SP41 SP40

SP28 NS9909 NS9904 SP36 SP34

SP06 NS9901 SP08 SP10 SP14 SP35 SP16 SP19 PZ02: ND SP76

NS9903 SP07 SP17 SP13 NS9906 SB06

SB01 SP58 SP87 SP86 SP59 SP60 SMW04: 6,800 µg/L SP49

SMW02: 2 µg/L SP61 SP62

SP88 SP69 SP70 SP71 SP72 SP73 SP74 SP75 SP85

B-2: ND PZ02 SP-5: ND SMW02: 1,200 µg/L NS001

SP-13 SP-14 SP-12 SP-15 SP-16 SB03 SB06 SB05 SB11 B-6 NS9912 SP11 SP01

SP-12: 0.48 µg/L B-3 SP-14: 1,200 µg/L SB09 SP12 SP02 SP19 SP15 SP16 SP16B

PZ03 SB01 SP04 SS04 SS03

B-7 B-4 SB07 SB12 SB04 B-1 SP14

SP-11: ND SP-8 SP10 NS9913 SP03 SP13 SS02

SP-1 SP-11 SP-10 SP-9 SB08 SB10 SB02 SB02 SP18

SP-2: ND B-5 PZ01: 0.2 µg/L SB04 SP09 SMW03: ND SP05 SS01 SP17

SP-2 SB01 SMW04: ND SP08 SP07 SP06 SB03

SP-3 SP-4

SMW01: ND

N W E S

0 25 50 75
SCALE IN FEET

NOTE: HISTORIC FEATURE LOCATIONS ARE APPROXIMATED

- MONITORING WELL EXCEEDING SCREENING LEVEL
- MONITORING WELL BELOW SCREENING LEVEL
- SOIL BORING EXCEEDING SCREENING LEVEL
- SOIL BORING BELOW SCREENING LEVEL
- PROPERTY BOUNDARY
- HISTORICAL SITE FEATURES
- COMED TUNNEL STRUCTURE
- MWRD DEEP TUNNEL/CHICAGO SEWER
- BUILDINGS

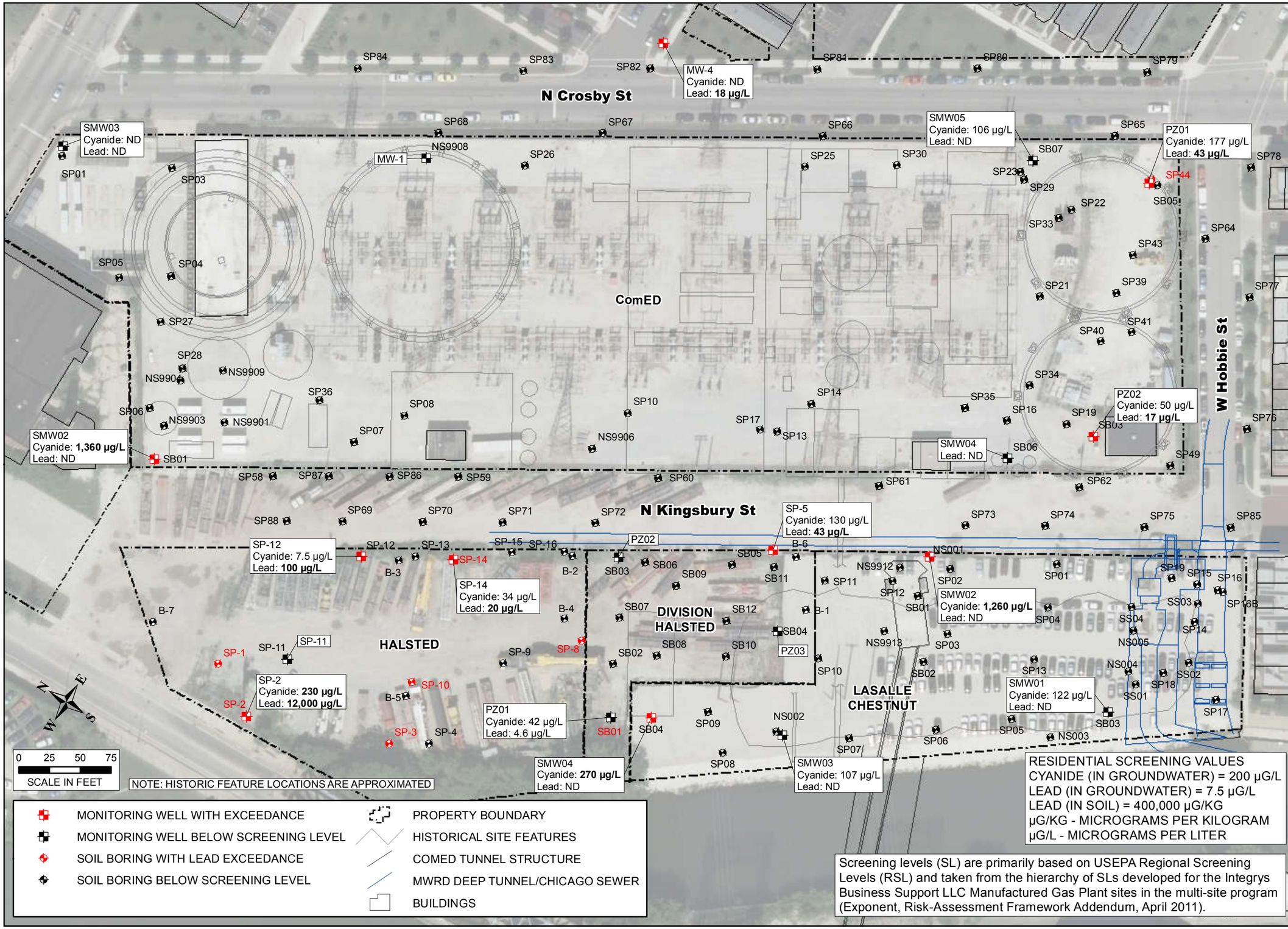
NAPHTHALENE SCREENING VALUES
RESIDENTIAL SOIL = 3,600 µg/Kg
RESIDENTIAL GROUNDWATER = 140 µg/L
µg/Kg - MICROGRAMS PER KILOGRAM
µg/L - MICROGRAMS PER LITER

Screening levels (SL) are primarily based on USEPA Regional Screening Levels (RSL) and taken from the hierarchy of SLs developed for the Integrys Business Support LLC Manufactured Gas Plant sites in the multi-site program (Exponent, Risk-Assessment Framework Addendum, April 2011).

PROJECT NO: 2034/5.1

FIGURE NO: 28

DRAWN BY/DATE:	TDC	11/28/11
CHECKED BY/DATE:	SLM	11/28/11
APPROVED BY/DATE:	SLM	11/28/11



RESIDENTIAL SCREENING VALUES
CYANIDE (IN GROUNDWATER) = 200 µG/L
LEAD (IN GROUNDWATER) = 7.5 µG/L
LEAD (IN SOIL) = 400,000 µG/KG
µG/KG - MICROGRAMS PER KILOGRAM
µG/L - MICROGRAMS PER LITER

Screening levels (SL) are primarily based on USEPA Regional Screening Levels (RSL) and taken from the hierarchy of SLs developed for the Integrys Business Support LLC Manufactured Gas Plant sites in the multi-site program (Exponent, Risk-Assessment Framework Addendum, April 2011).

NATURAL RESOURCE TECHNOLOGY

LEAD AND CYANIDE EXCEEDANCE IN SOIL AND GROUNDWATER

SITE SPECIFIC WORK PLAN NORTH STATION OPERABLE UNIT CHICAGO, ILLINOIS

PROJECT NO: 2034/5.1

FIGURE NO: 29

DRAWN BY/DATE:	TDC	11/28/11
CHECKED BY/DATE:	SLM	11/28/11
APPROVED BY/DATE:	SLM	11/28/11

NATURAL RESOURCE TECHNOLOGY

ARSENIC EXCEEDANCES IN SOIL AND GROUNDWATER

SITE SPECIFIC WORK PLAN
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

N Crosby St

N Kingsbury St

W Hobbie St

ComED

DIVISION HALSTED

HALSTED

LASALLE CHESTNUT

MW-4 Arsenic: ND

SMW03 Arsenic: ND

SMW05 Arsenic: ND

PZ01 Arsenic: ND

PZ02 Arsenic: ND

SMW02 Arsenic: ND

SWM04 Arsenic: ND

SWM01 Arsenic: ND

SMW04 Arsenic: ND

SMW03 Arsenic: ND

SP-12 Arsenic: **14 µg/L**

SP-14 Arsenic: 8.7 µg/L

SP-5 Arsenic: **13 µg/L**

SP-2 Arsenic: **470 µg/L**

PZ01 Arsenic: 5.8 µg/L

0 25 50 75
SCALE IN FEET

NOTE: HISTORIC FEATURE LOCATIONS ARE APPROXIMATED

- MONITORING WELL WITH EXCEEDANCE
- MONITORING WELL BELOW SCREENING LEVEL
- SOIL BORING WITH ARSENIC EXCEEDANCE
- SOIL BORING BELOW SCREENING LEVEL
- PROPERTY BOUNDARY
- HISTORICAL SITE FEATURES
- COMED TUNNEL STRUCTURE
- MWRD DEEP TUNNEL/CHICAGO SEWER
- BUILDINGS

ARSENIC SCREENING VALUES
RESIDENTIAL SOIL = 13,000 µG/KG
RESIDENTIAL GROUNDWATER = 10 µG/L
µG/KG - MICROGRAMS PER KILOGRAM
µG/L - MICROGRAMS PER LITER

1. Screening levels (SL) are primarily based on USEPA Regional Screening Levels (RSL) and taken from the hierarchy of SLs developed for the Integrys Business Support LLC Manufactured Gas Plant sites in the multi-site program (Exponent, Risk-Assessment Framework Addendum, April 2011).
2. The SL used for arsenic in residential soil is the background concentration for metropolitan counties of IL as presented in the Illinois Tiered Approach to Corrective Action Objectives (TACO-Table G), 13.0 mg/kg.

PROJECT NO: 2034/5.1

FIGURE NO: 30

DRAWN BY/DATE:	TDC	11/28/11
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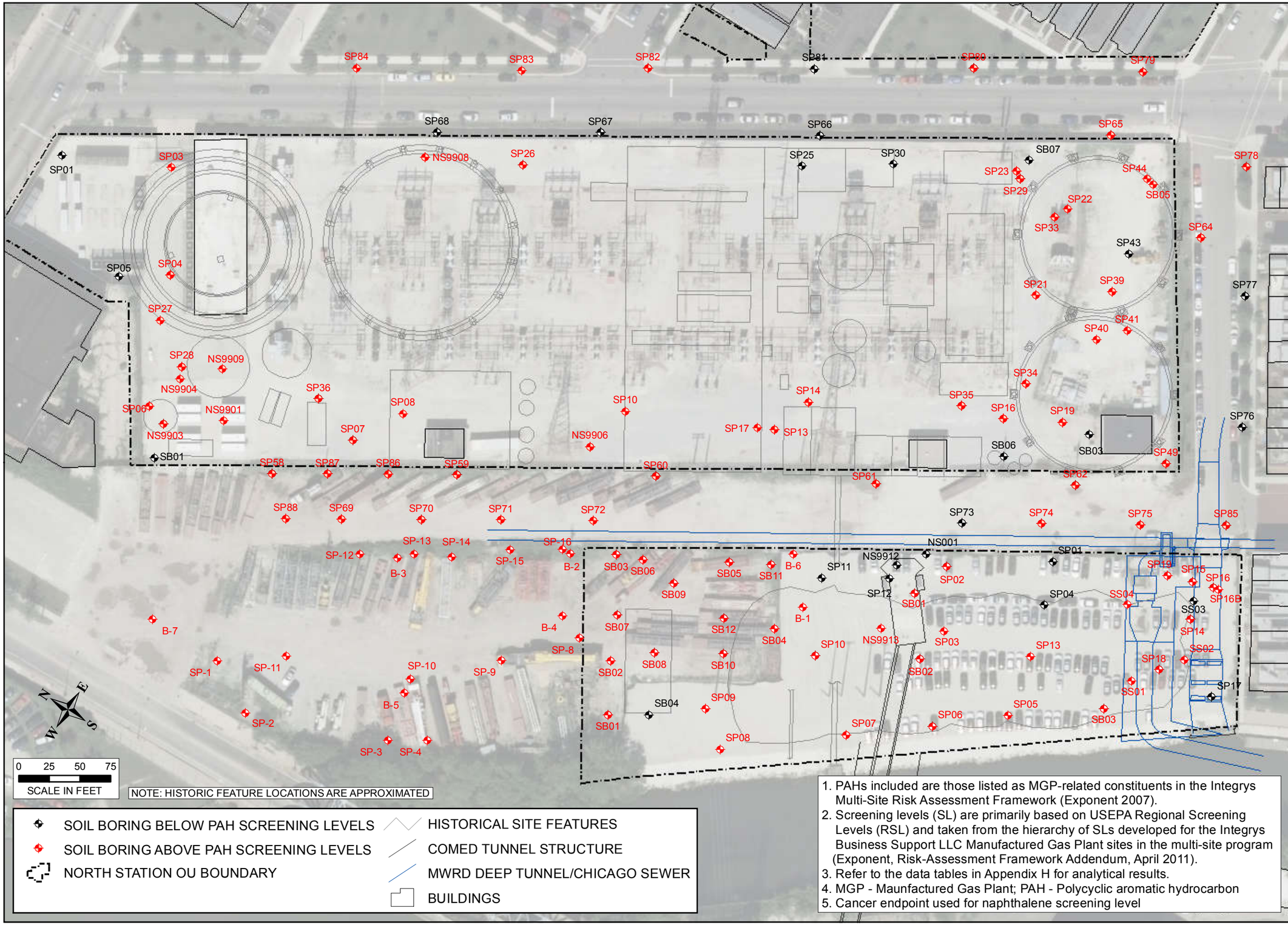

NOTE: HISTORIC FEATURE LOCATIONS ARE APPROXIMATED

- SOIL BORING BELOW PAH SCREENING LEVELS
- SOIL BORING ABOVE PAH SCREENING LEVELS
- NORTH STATION OU BOUNDARY
- HISTORICAL SITE FEATURES
- COMED TUNNEL STRUCTURE
- MWRD DEEP TUNNEL/CHICAGO SEWER
- BUILDINGS

1. PAHs included are those listed as MGP-related constituents in the Integrys Multi-Site Risk Assessment Framework (Exponent 2007).
2. Screening levels (SL) are primarily based on USEPA Regional Screening Levels (RSL) and taken from the hierarchy of SLs developed for the Integrys Business Support LLC Manufactured Gas Plant sites in the multi-site program (Exponent, Risk-Assessment Framework Addendum, April 2011).
3. Refer to the data tables in Appendix H for analytical results.
4. MGP - Maunfactured Gas Plant; PAH - Polycyclic aromatic hydrocarbon
5. Cancer endpoint used for naphthalene screening level

NATURAL RESOURCE TECHNOLOGY

PAH EXCEEDANCES IN SOIL INDUSTRIAL SCREENING LEVELS

SITE SPECIFIC WORK PLAN NORTH STATION OPERABLE UNIT CHICAGO, ILLINOIS

PROJECT NO: 2034/5.1

FIGURE NO: 31

DRAWN BY/DATE:	TDC	11/2/11
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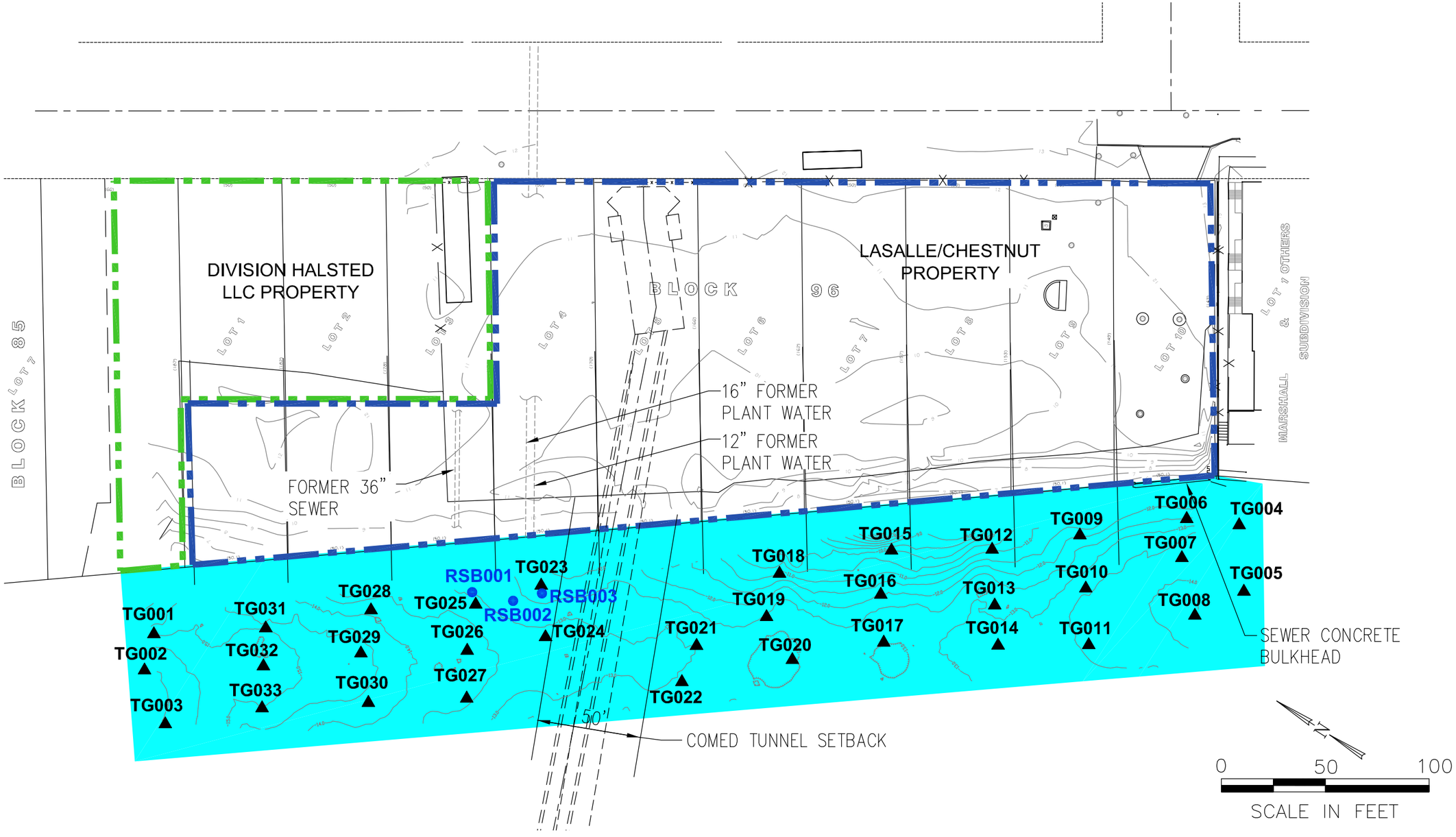
APPROVED BY/DATE:	SLM	11/2/11

TARGOST SAMPLE LOCATIONS

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

DRAWN BY:	RLH	DATE: 08/03/11
CHECKED BY:	RJK	DATE: 08/03/11
APPROVED BY:	JMK	DATE: 08/03/11

DRAWING NO: FIG-32
REFERENCE:.



LASALLE/CHESTNUT PROPERTY LINE
DIVISION HALSTED LLC PROPERTY
TARGOST PROBE LOCATION
RIVER SEDIMENT SAMPLING LOCATION
INVESTIGATION AREA

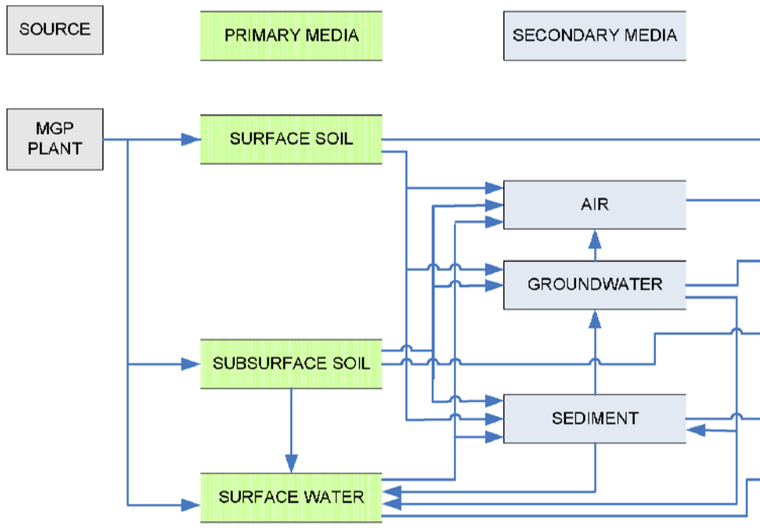
NOTE:
WIDTH AND LOCATION OF SETBACK ARE APPROXIMATE

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "SEDIMENT INVEST SAMPLES.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
32



EXPOSURE ROUTE	HUMAN RECEPTORS				ECOLOGICAL RECEPTORS			
	INDUSTRIAL/ COMMERCIAL WORKER	CONSTRUCTION WORKER	RECREATIONAL	RESIDENTIAL	BIRDS	MAMMALS	FISH	BENTHIC INVERTEBRATES
INGESTION	●	●	○	●	○	○	NA	NA
DERMAL	●	●	○	●	○	○	NA	NA
INHALATION	●	●	○	●	○	○	NA	NA
INGESTION	●	●	○	●	○	○	NA	NA
DERMAL	●	●	○	●	○	○	NA	NA
INGESTION	●	●	○	●	○	○	NA	NA
DERMAL	●	●	○	●	○	○	NA	NA
INGESTION	○	●	○	○	○	○	●	●
DERMAL	○	●	○	○	○	○	●	●
INGESTION	○	●	●	○	○	○	●	●
DERMAL	○	●	●	○	○	○	●	●
INGESTION	○	●	●	○	○	○	●	●
DERMAL	○	●	●	○	○	○	●	●

LEGEND:

- ● Pathway potentially complete and warrants further evaluation within the Baseline Risk Assessment. The level of evaluation will depend upon site conditions.
- ○ Pathway not complete or considered insignificant; No further evaluation is recommended unless warranted based on site-specific conditions.

NA: Not Applicable

DRAWN BY: RLH DATE: 08/03/11
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APPROVED BY: SLM DATE: 08/03/11
DRAWING NO: FIG-33
REFERENCE: .

SITE-SPECIFIC CONCEPTUAL SITE MODEL

NORTH STATION OPERABLE UNIT
INTEGRYS BUSINESS SUPPORT, LLC
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/5

FIGURE NO.
33

NATURAL RESOURCE TECHNOLOGY

PROPOSED UPLAND SAMPLING LOCATIONS MAP

SITE SPECIFIC WORK PLAN
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NOS-SG17
NOS-SG18
NOS-SB105
NOS-SB104
NOS-SG12
NOS-MWW/P103
NOS-SG9
NOS-SG10
NOS-SG8
NOS-MWW104
NOS-SG11
NOS-MWW/P105
NOS-SG13
NOS-SS105
NOS-SG1
NOS-SS106
NOS-SS107
NOS-SS108
NOS-MWW116
NOS-SS109
NOS-SS104
NOS-SG14
NOS-MWW102
NOS-SG5
NOS-SG4
NOS-SG2 / SU1
NOS-MWW/P106
NOS-SB101
NOS-SS113
NOS-SS110
NOS-SG6
NOS-SS112
NOS-MWW/P101
NOS-SG7
NOS-SB102
NOS-SS111
NOS-SG3
NOS-SG15
NOS-MWW/P114
NOS-SB103
NOS-MWW/P115
NOS-AREA102
NOS-AREA101
NOS-MWW/P107
NOS-MWW/P113
NOS-SG16
NOS-MWW/P108
NOS-MWW/P112
NOS-MWW/P110
NOS-MWW/P109
NOS-MWW/P111

0 50 100
SCALE IN FEET

- WATER TABLE WELL
- GROUNDWATER WELL NEST
- SOIL GAS PROBE/SUMP HEADSPACE SAMPLE
- SUMP WATER SAMPLE
- SOIL BORING - SURFACE AND SUBSURFACE SAMPLES
- SURFACE SOIL SAMPLE
- AREAS OF SUBSURFACE EXPLORATION
- HISTORICAL SITE FEATURES
- COMED TUNNEL STRUCTURE
- MWRD DEEP TUNNEL/CHICAGO SEWER
- NORTH STATION OU BOUNDARY
- BUILDINGS
- ELECTRIC LINE
- GAS LINE
- PHONE LINE
- SEWER
- SEWER (KNOWN DIRECTION)
- WATER MAIN

INVESTIGATIONS WILL PROCEED ON THE COMED PARCEL ONLY IF THE WORK CAN BE PERFORMED SAFELY AND WITHIN COMED OPERATIONAL REQUIREMENTS, AND IT DOES NOT IMPACT SERVICE AT THE SUBSTATION.

UTILITY POSITIONS ARE APPROXIMATE
DO NOT USE FOR CONSTRUCTION PURPOSES
HISTORIC FEATURE LOCATIONS ARE APPROXIMATED

PROJECT NO: 2034/5.1

FIGURE NO: 34

DRAWN BY/DATE:	TDC	11/17/11
CHECKED BY/DATE:	SLM	11/17/11
APPROVED BY/DATE:	SLM	11/17/11

SEDIMENT SAMPLE LOCATION

AMBIENT SURFACE WATER SAMPLE

CO-LOCATED SURFACE WATER SAMPLE

RIVER SAMPLE GRID

HISTORICAL SITE FEATURES

OPERABLE UNIT BOUNDARY

RIVER

NOTES:
SEDIMENT SAMPLE LOCATIONS DEVELOPED USING ESRI ARCGIS "CREATE RANDOM POINTS" TOOL.

0 500 1,000
SCALE IN FEET

N E S W

SWA-1NOS
SWA-2NOS
SWA-3NOS
SWA-4NOS

0 55 110
SCALE IN FEET

12" FORMER PLANT WATER
16" FORMER PLANT WATER
FORMER 36" SEWER
SEWER CONCRETE BULKHEAD
50' COMED TUNNEL SETBACK

PCA-1NOS
PCA-2NOS
PCA-3NOS
PCA-4NOS/ SWS-4NOS
PCA-5NOS
PCA-6NOS
PCA-7NOS
PCA-8NOS
PCA-9NOS
PCA-10NOS/ SWS-10NOS
PCA-11NOS
PCA-12NOS
PCA-13NOS/ SWS-13NOS
PCA-14NOS
PCA-15NOS
PCA-16NOS
PCA-17NOS
PCA-18NOS
PCA-19NOS
PCA-20NOS/ SWS-20NOS
PCA-21NOS
PCA-22NOS
PCA-23NOS
PCA-24NOS
PCA-25NOS
PCA-26NOS
PCA-27NOS
PCA-28NOS
PCA-29NOS
PCA-30NOS
PCA-31NOS
PCA-32NOS
PCA-33NOS

NATURAL RESOURCE TECHNOLOGY

PROPOSED RIVER SAMPLING LOCATIONS

SITE SPECIFIC WORK PLAN
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

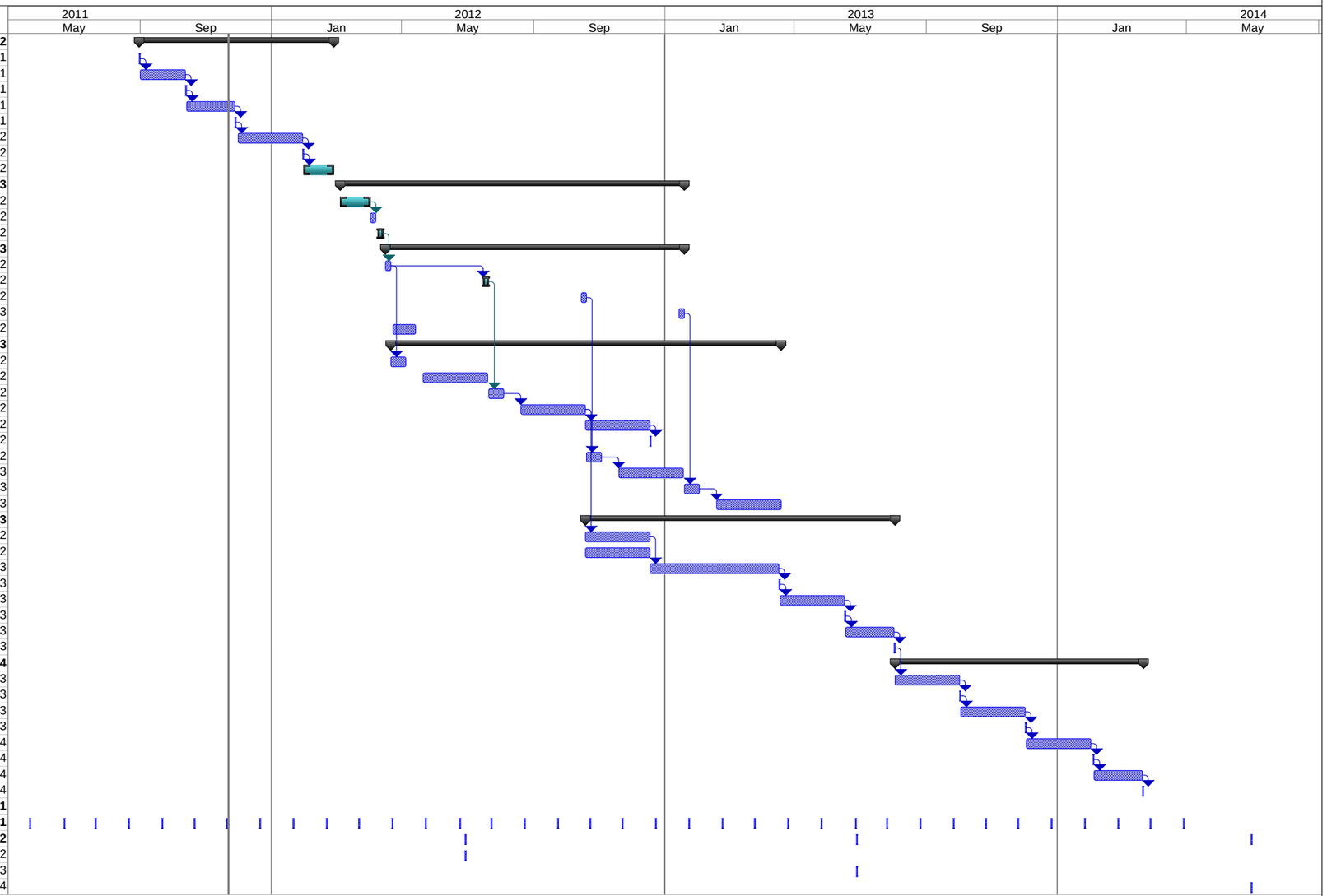
PROJECT NO: 2034/5.0

FIGURE NO: 35

DRAWN BY/DATE:	TDC	8/9/11
CHECKED BY/DATE:	SLM	8/9/11
APPROVED BY/DATE:	SLM	8/10/11

FIGURE 36
RI/FS Preliminary Schedule
North Station OU
Peoples Gas

ID	Task Name	Duration	Start	Finish
1	**Preparation for RI Field Activites**	**181 days**	**Wed 8/31/11**	**Mon 2/27/12**
2	Site Specific Work Plan Revision 0 to USEPA	1 day	Wed 8/31/11	Wed 8/31/11
3	USEPA Review of SSWP Rev 0	42 days	Thu 9/1/11	Wed 10/12/11
4	Receive Comments on SSWP Rev 0	1 day	Thu 10/13/11	Thu 10/13/11
5	Prepare SSWP Revision 1	45 days	Fri 10/14/11	Sun 11/27/11
6	SSWP Revision 1 to USEPA	1 day	Mon 11/28/11	Mon 11/28/11
7	USEPA Review of SSWP Rev 1	60 days	Thu 12/1/11	Sun 1/29/12
8	USEPA Approval of SSWP Rev 1	1 day	Mon 1/30/12	Mon 1/30/12
9	Field Activites and Contract Preparation	4 wks	Tue 1/31/12	Mon 2/27/12
10	**Field Activites**	**320 days**	**Mon 3/5/12**	**Fri 1/18/13**
11	Soil Boring/GW Monitoring Well Installation	4 wks	Mon 3/5/12	Sun 4/1/12
12	Soil Gas Sampling	5 days	Mon 4/2/12	Fri 4/6/12
13	Develop Groundwater Monitoring Wells	5 days	Mon 4/9/12	Fri 4/13/12
14	**Quarterly Groundwater Sampling**	**278 days**	**Mon 4/16/12**	**Fri 1/18/13**
15	First Quarter Sampling Event	5 days	Mon 4/16/12	Fri 4/20/12
16	Second Quarter Sampling Event	5 days	Mon 7/16/12	Fri 7/20/12
17	Third Quarter Sampling Event	5 days	Mon 10/15/12	Fri 10/19/12
18	Fourth Quarter Sampling Event	5 days	Mon 1/14/13	Fri 1/18/13
19	**Sediment and Surface Water Sampling**	3 wks	Mon 4/23/12	Sun 5/13/12
20	**Data Evaluation Activites**	**363 days**	**Sat 4/21/12**	**Thu 4/18/13**
21	Laboratory Analysis 1st Qtr event	14 days	Sat 4/21/12	Fri 5/4/12
22	Data Validation 1st Qtr event	60 days	Mon 5/21/12	Thu 7/19/12
23	Laboratory Analysis 2nd Qtr event	14 days	Sat 7/21/12	Fri 8/3/12
24	Data Validation 2nd Qtr event	60 days	Mon 8/20/12	Thu 10/18/12
25	Vapor Intrusion Evaluation Based on Groundwater Data	60 days	Fri 10/19/12	Mon 12/17/12
26	Submit Vapor Intrusion Evaluation to USEPA	1 day	Tue 12/18/12	Tue 12/18/12
27	Laboratory Analysis 3rd Qtr event	14 days	Sat 10/20/12	Fri 11/2/12
28	Data Validation 3rd Qtr event	60 days	Mon 11/19/12	Thu 1/17/13
29	Laboratory Analysis 4th Qtr event	14 days	Sat 1/19/13	Fri 2/1/13
30	Data Validation 4th Qtr event	60 days	Mon 2/18/13	Thu 4/18/13
31	**Remedial Investigation Report**	**288 days**	**Fri 10/19/12**	**Fri 8/2/13**
32	Baseline Risk Assessment	60 days	Fri 10/19/12	Mon 12/17/12
33	Current and Future Land Reuse Assessment	60 days	Fri 10/19/12	Mon 12/17/12
34	Prepare RI Report	120 days	Tue 12/18/12	Tue 4/16/13
35	Submit RI Report, Rev 0 to USEPA	1 day	Wed 4/17/13	Wed 4/17/13
36	USEPA Review of RI, Rev 0	60 days	Thu 4/18/13	Sun 6/16/13
37	Receive Comments on Draft RI Rport	1 day	Mon 6/17/13	Mon 6/17/13
38	Finalize RI Report	45 days	Tue 6/18/13	Thu 8/1/13
39	Final RI Report to USEPA	1 day	Fri 8/2/13	Fri 8/2/13
40	**Feasibility Study Report**	**231 days**	**Sat 8/3/13**	**Fri 3/21/14**
41	Develop and Screen Alternatives	60 days	Sat 8/3/13	Tue 10/1/13
42	Submit Alternatives to USEPA	1 day	Wed 10/2/13	Wed 10/2/13
43	Prepare FS Report Rev 0	60 days	Thu 10/3/13	Sun 12/1/13
44	FS Report Rev 0 to USEPA	1 day	Mon 12/2/13	Mon 12/2/13
45	USEPA review of FS, Rev 0	60 days	Tue 12/3/13	Fri 1/31/14
46	Receive USEPA Comments on Draft FS Report	1 day	Mon 2/3/14	Mon 2/3/14
47	Finalize FS Report	45 days	Tue 2/4/14	Thu 3/20/14
48	Final FS Report to USEPA	1 day	Fri 3/21/14	Fri 3/21/14
49	**Project Management Reporting**	**1 day**	**Fri 7/15/11**	**Fri 7/15/11**
50	**Monthly Progress Report**	**1 day**	**Fri 7/15/11**	**Fri 7/15/11**
91	**Annual Progress Report**	**1 day**	**Fri 6/29/12**	**Fri 6/29/12**
92	Annual Progress Report 1	1 day	Fri 6/29/12	Fri 6/29/12
93	Annual Progress Report 2	1 day	Fri 6/28/13	Fri 6/28/13
94	Annual Progress Report 3	1 day	Mon 6/30/14	Mon 6/30/14



Project: SSWP Schedule Figure
Date: Tue 11/22/11

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Progress
Deadline

This preliminary schedule is dependent on USEPA Approval and weather conditions for field work.
Modification will be in accordance with the AOC/SOW

AMBIENT SEDIMENT SAMPLE LOCATIONS
NORTH STATION OU BOUNDARY
RIVER

NOTE: AMBIENT SEDIMENT SAMPLES COLLECTED IN MARCH 2011.

SCR-02
SCR-03
ACR-8
ACR-7
ACR-6
ACR-5
ACR-12
ACR-21
SCR-09
ACR-15
ACR-18
ACR-19
SCR-11
ACR-17
ACR-20
ACR-13
SCR-08
SCR-05
SCR-04
SCR-10
ACR-14
ACR-16
ACR-4
ACR-3
ACR-2
ACR-1
SCR-01
ACR-10
ACR-9
ACR-11
NORTH STATION OU

N E S W

0 500 1,000
SCALE IN FEET

NATURAL RESOURCE TECHNOLOGY

AMBIENT SEDIMENT SAMPLE LOCATIONS

SITE SPECIFIC WORK PLAN
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

PROJECT NO: 2034/5.0

FIGURE NO: 37

DRAWN BY/DATE:	TDC	8/3/11
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APPROVED BY/DATE:	SLM	8/10/11

TABLES

Table 1: Site-Specific COPCs for Soil, Groundwater, Sediment, Surface Water and Soil Gas
North Station Operable Unit Site-Specific Work Plan

COPCs	Parcels			
	ComEd, LaSalle Chestnut, Division-Halsted and City Right-of-Ways	Division and Halsted	Old Town Village West	North Branch Canal
Soil				
North Station Site-Specific COPC list[a]	X			
Multi-site RAF COPC list[b]		X	X	
PCBs		X	X	
TCL VOCs			X	
Groundwater				
North Station Site-Specific COPC list[a]	X	X	X	
Total antimony	X	X	X	
Total lead	X	X	X	
Available cyanide	X	X	X	
Phenol	X	X	X	
Styrene	X	X	X	
Sediment				
Multi-Site RAF COPC list[b]				X
Surface Water				
Multi-Site RAF COPC list[b]				X
Soil Gas				
Multi-Site RAF PVOCs	X	X	X	
Naphthalene	X	X	X	
North Station Site-Specific Volatile Organic VI COPC list[c]	X	X	X	

NOTES:

X - Parameter selected as COPC

Shaded box indicates that matrix does not apply to the parcel.

[a] North Station Site-Specific COPC list includes: PVOCs from the multi-site RAF list, PAHs form the multi-site RAF list, 2-methylnaphthalene, dibenzofuran, total arsenic, total lead, and PCBs.

[b] The constituents on the Multi-Site RAF COPC list are presented in Appendix D-1.

[c] North Station Site-Specific Volatile Organic COPC list includes: 1,1,1-Trichloroethane, 1,1,2,2-Tetrachloroethane, 1,1-Dichloroethane, 1,1-Dichloroethene, 2-Hexanone, 4-Methyl-2-pentanone, Acetone, Bromodichloromethane, Bromomethane, Carbon disulfide, Chloroethane, Chloroform, Chloromethane, Methyl ethyl ketone, Methylene chloride and Styrene.

COPC - Constituents of potential concern
PAH - Polycyclic aromatic hydrocarbon
PCB - Polychlorinated biphenyl
PVOC - Petroleum VOC
RAF - Risk Assessment Framework
TCL - Target Compound List
VI - Vapor Intrusion
VOC - Volatile organic compound

Table 2 - Sampling and Analysis Plan Summary
North Station Operable Unit
Kingsbury and Hobbie Streets, Chicago, Illinois
USEPA ILD982074775

Sample Type	Sample Frequency	Estimated Number of Samples per Event[1]	Parameter	Method	Field Duplicates[2] (1 extra volume)	MS/MSD[3] (2 extra volumes)	Equipment Blanks	Trip Blanks	TOTAL[4]	Estimated No. of Containers	Container Type	Minimum Volume	Preservation (Cool All Samples to 4° ± 2°C Unless 'None' Indicated)	Holding Time from Sample Date
Soil														
Soil ComEd Parcel (HHRA and Feasibility Study)	10 surface (0-6") or near-surface samples 6 subsurface (6"-24") samples[19]	16	PVOCs[17]	5035/8260B	1	1	Equipment blanks will be collected at a frequency of 1 per soil or sediment sampling day with non-dedicated sampling equipment.	VOC trip blanks will accompany each cooler containing VOC samples.	24	24 sets	5 g Encores (3/sample)	15 g	--	14 days
			PAHs[16]	8270 SIM	1	1			21	21	Amber Glass	8 oz	--	14/40 days
			2-Methylnaphthalene, Dibenzofuran	8270C	1	1			21	21	Amber Glass	8 oz	--	14/40 days
			Total Arsenic and Lead	6020A/7471A	1	1			21	21	Plastic	8 oz	--	6 mo./ 28 days for Hg
			PCBs	8081	1	1			21	21	Amber Glass	8 oz	--	14/40 days
Soil LaSalle Chestnut Parcel Division Halsted Parcel City ROWs (HHRA and Feasibility Study)	1 surface (0-6") or near-surface sample per boring 1 subsurface (6"-24") sample[19] per two borings 1 subsurface (>24") sample[20] per boring	(12 borings) 30	PVOCs[17]	5035/8260B	2	2			40	40 sets	5 g Encores (3/sample)	15 g	--	14 days
			PAHs[16]	8270 SIM	2	2			37	37	Amber Glass	8 oz	--	14/40 days
			2-Methylnaphthalene, Dibenzofuran	8270C	2	2			37	37	Amber Glass	8 oz	--	14/40 days
			Total Arsenic and Lead	6020A/7471A	2	2			37	37	Plastic	8 oz	--	6 mo./ 28 days for Hg
			PCBs	8081	2	2			37	37	Amber Glass	8 oz	--	14/40 days
Soil Halsted Parcel Division Parcel (HHRA and Feasibility Study)	1 surface (0-6") or near-surface sample per boring 1 subsurface (6"-24") sample[19] per two borings 1 subsurface (>24") sample[20] per boring	(7 borings) 18	PVOCs[17]	5035/8260B	1	1			25	25 sets	5 g Encores (3/sample)	15 g	--	14 days
			PAHs[10]	8270 SIM	1	1			20	20	Glass Jar	8 oz	--	14/40 days
			Metals[8]	6020A/7471A	1	1			20	20	Plastic	8 oz	--	6 mo./ 28 days for Hg
			Total Cyanide	9012A	1	1			20	20	Plastic	8 oz	--	14 days
			PCBs	8081	1	1			20	20	Glass Jar	8 oz	--	14/40 days
Soil Old Town Village West Parcel (HHRA and Feasibility Study)	1 surface (0-6") or near-surface sample per boring 1 subsurface (6"-24") sample[19] per two borings 1 subsurface (>24") sample[20] per boring	(2 borings) 5	TCL VOCs	5035/8260B	1	1			8	8 sets	5 g Encores (3/sample)	15 g	--	14 days
			PAHs[10]	8270 SIM	1	1			7	7	Glass Jar	8 oz	--	14/40 days
			Metals[8]	6020A/7471A	1	1			7	7	Plastic	8 oz	--	6 mo./ 28 days for Hg
			Total Cyanide	9012A	1	1			7	7	Plastic	8 oz	--	14 days
			PCBs	8081	1	1			7	7	Glass Jar	8 oz	--	14/40 days
Soil (Soil Vapor Assessment) Chemical Parameters	Up to 2 subsurface (>24") samples per boring	(16 borings) 32	PVOCs[17]	5030B/8260B	2	2			38	38 sets	Glass Vial	Three 40 mL	MeOH	14 days
			PAHs[16]	8270 SIM	2	2			36	36	Amber Glass	Two 1 L	--	14/40 days
			2-Methylnaphthalene, Dibenzofuran	8270C	2	2			36	36	Amber Glass	500 mL	--	14/40 days
			Total Arsenic and Lead	6020A/7471A	2	2			36	36	Plastic	250 mL	--	6 mo./ 28 days for Hg
			PCBs	8081	2	2			36	36	Amber Glass	Two 1 L	--	14/40 days
Soil (Soil Vapor Assessment) Geotechnical Parameters	up to 4 samples total	4	Grain Size Distribution	ASTM D421/D422	--	--			4	4	16 oz glass	16 oz	None	--
			Moisture Content	ASTM D2216	--	--			4	4	16 oz glass	16 oz	keep in dark	28 days
			Bulk Density	ASTM D2937	--	--			4	4	Undisturbed Sample from Shelby Tube	Shelby Tube	None	--
			Specific Gravity of Soil Solids	ASTM D854	--	--			4	4			None	--
Soil Waste Characterization														
Soil Waste Characterization	Composite	1	Protocol B (Verify with receiving facility)	Various	--	--	--	--	1	1	Glass Jars	32 oz	--	varies
Groundwater														
Groundwater - Wells and Sumps[21] (Risk Assessment, Feasibility)	Groundwater will be sampled quarterly for one year following well installation; parameters may change after 6 months depending on initial results. See Sections 3.8 and 6.5.5. Sump will be sampled concurrent with vapor at Building 1.	(29 wells and 1 sump) 29	PVOCs[17] and Styrene	8260B	3	2	--	VOC trip blanks will accompany each cooler containing VOC samples.	38	38 sets	Glass Vial	Three 40 mL	HCl to pH<2, Zero Headspace	14 days
			PAHs[16]	8270 SIM	3	2	--		35	35 sets	Amber Glass	1 L	--	7/40 days
			2-Methylnaphthalene, Dibenzofuran and Phenol	8270C	3	2	--		35	35 sets	Amber Glass	1 L	--	7/40 days
			Total Antimony, Arsenic, Lead	6020 or 7470A	3	2	--		35	35	Plastic	500 ml	HNO3 to pH <2	6 mo./ 28 days for Hg
			PCBs	8081	3	2	--		35	35	Amber Glass	1 L	--	7/40 days
			Available Cyanide	OIA-1677	3	2	--		35	35	Amber Plastic	500 ml	PbCO3; NaOH to pH>12	14 days
			GW Field Parameters[9]	Field	--	--	--	--	30	--	Field Measured	--	--	--
Water Waste Characterization														
Water Waste Characterization	Composite	1	Code B - CID Bio	Various	--	--	--		1	1	Glass Jar	32 oz	--	varies
Surface Water														
Surface Water	Surface water will be sampled during one event concurrent with sediment sampling. Surface water will be sampled on two events concurrent with groundwater sampling during the spring (high river stage) and summer (low river stage).	(8 stations) 8 and (2 stations) 2	PVOCs[17]	8021B or 8260B	1	1	--	VOC trip blanks will accompany each cooler containing VOC samples.	14	14 sets	Glass Vial	Three 40 mL	HCl to pH<2, Zero Headspace	14 days
			PAHs[16]/Phenols[7]	8270C or 8270 SIM	1	1	--		12	12 sets	Amber Glass	1 L	--	7/40 days
			Dissolved Metals[11]	6020 or 7470A	1	1	--		12	12	Plastic	500 mL	HNO3 to pH <2	6 mo./ 28 days for Hg
			Available Cyanide	OIA-1677	1	1	--		12	12	Amber Plastic	500 mL	PbCO3; NaOH to pH>12	14 days
			Hardness	6020	1	1	--		12	12	Plastic	500 mL	HNO3 to pH <2	28 days
			Field Parameters[12]	Field	--	--	--		10	--	field measured	--	--	--
Sediment Samples														
Sediment (Surface 0-6 inches) Step I	Chemical Analysis 1 surface (0-6") sample per core	(33 cores) 33	PVOCs[17]	8260B	2	2	Equipment blanks will be collected at a frequency of 1 per soil or sediment sampling day with non-dedicated sampling equipment.	VOC trip blanks will accompany each cooler containing VOC samples, including equipment blanks.	57	57	Glass	4 oz	MeOH	14 days
			Phenols[7]	8270C	2	2			47	47	Amber Glass	8 oz	--	14/40 days
			34 PAHs[10]	8270C or 8270 SIM	2	2			47	47	Amber Glass	8 oz	--	14/40 days
			Metals[11]	6020A or 7471A	2	2			47	47	Plastic	125 ml	--	6 mo./ 28 days for Hg
			Percent Solids	Various	0	--			33	33	Glass	4 oz	keep in dark	28 days
			Cyanide	9012A	2	2			47	47	Plastic	125 ml	--	14 days
			Total Organic Carbon	Lloyd Kahn Method	2	2			47	47	Plastic	100 g	keep in dark	28 days
			Black Carbon[13]	Refer to Note 13	2	2			47	47	Plastic	500 g	keep in dark	28 days
	Toxicity Testing	10	Toxicity Testing[14]	Refer to Note 14	0	0			10	10	Plastic	2 L	keep in dark	--
			Ammonia	350.1	1	1			12	12	Plastic	10 g	--	28 days
			Total Sulfide	9030	1	1			12	12	Amber Glass	25 g (min)	Zero Headspace	7 days

Sample Type	Sample Frequency	Estimated Number of Samples per Event[1]	Parameter	Method	Field Duplicates[2] (1 extra volume)	MS/MSD[3] (2 extra volumes)	Equipment Blanks	Trip Blanks	TOTAL[4]	Estimated No. of Containers	Container Type	Minimum Volume	Preservation (Cool All Samples to 4° ± 2°C Unless 'None' Indicated)	Holding Time from Sample Date
Sediment Samples Continued														
Sediment (Subsurface) Step I	1 subsurface 6"-18" sample per core 1 subsurface 18"-30" sample per core Up to 4 subsurface >30" samples per core	198	PVOCs[17]	8260B	10	10	Equipment blanks will be collected at a frequency of 1 per soil or sediment sampling day with non-dedicated sampling equipment.	VOC trip blanks will accompany each cooler containing VOC samples, including equipment blanks.	238	238	Glass	4 oz	methanol	14 days
			PAHs[16]/Phenols[7]	8270 SIM/8270C	10	10			228	228	Amber Glass	8 oz	--	14/40 days
			Metals[11]	6020A or 7471A	10	10			228	228	Plastic	125 mL	--	6 mo./ 28 days for Hg
			PCBs	8081	10	10			228	228	Amber Glass	8 oz	--	14/40 days
			Percent Solids	Various	10	10			228	228	Glass	4 oz	keep in dark	28 days
			Cyanide	9012A	10	10			228	228	Plastic	125 mL	--	14 days
	One of every 10 subsurface samples (biased to visibly contaminated samples)	20	Total Organic Carbon	Lloyd Kahn Method	1	1			26	26	Plastic	100 g	keep in dark	28 days
			34 PAHs[10]	8270 SIM	1	1			24	24	Amber Glass	8 oz	--	14/40 days
			Black Carbon[13]	Refer to Note 13	1	1			24	24	Plastic	500 g	keep in dark	28 days
Sediment (FS Parameters)	Up to 10 cores	10	Grain Size Distribution (sieve and hydrometer)	ASTM D421, 422	--	--	--		10	10	5 Gallon Bucket	5 gal	None	--
			Atterberg Limits	ASTM D4318	--	--	--	--	10	10	Glass or Plastic	8 oz	None	--
			Organic Content by LOI	ASTM D2974	--	--	--	--	10	10	Plastic	100 g	keep in dark	28 days
			Moisture Content	ASTM D2216	--	--	--	--	10	10	Glass or Plastic	8 oz	None	--
Sediment Waste Characterization														
Sediment Waste Characterization	Composite	1	Protocol B (Verify with receiving facility)	Various	--	--	--	--	1	1	Glass Jar	32 oz	--	varies
Soil Gas														
Soil Gas (HHRA Indoor air pathway)	16 locations @ 2 samples per location 2 locations @ 1 sample per location (sump headspace samples)	34	PVOCs[17]	TO-15	4	--	--	--	38	38	Summa Canister	<1 L[18]	--	30 days
			Site-Specific VOCs[15]		4	--	--	--	38					
			Naphthalene		4	--	--	--	38					

Notes:

1. Proposed number of samples do not include contingency investigation locations.
2 Field duplicates will be collected at a frequency of 1 per 10 or fewer investigative water and soil vapor samples, and 1 per 20 or fewer investigative soil/sediment samples.
3 Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples will be collected at a frequency of 1 per group of 20 or fewer investigative water samples or soil samples. Additional volume will be determined by laboratory requirements.
4. Includes estimated number of trip blanks and equipment blanks, based on number of days sampling and estimated number of coolers.
7. Phenols include 2, 4-dimethylphenol, 2-methylphenol, 4-methylphenol, and phenol (acid-extractable organic compounds).
8. Metals as listed in the Muti-Site RAF including aluminum, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium and zinc.
9. Field parameters for groundwater include temperature, pH, specific conductivity, oxidation-reduction potential, and dissolved oxygen.
10. PAH analysis for these sediments include a list of 34 PAHs, including chain parameters as provided in USEPA Guidance Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures, 2002 by SW-846 Method 8270C with gas chromatograph/mass spectrometry in selected ion mode of operation.
For a complete list of the 34 PAHs see Appendix D, Attachment D-1.
11. Metals in surface water and sediment include aluminum, antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium and zinc.
12. Surface water field parameters include temperature, pH, specific conductivity, oxidation-reduction potential, dissolved oxygen, and turbidity.
13. Black Carbon ("Soot" Carbon) is the remaining carbon after muffle furnace drying and acid treatment of sediments to remove other forms of carbon.
14. The *Hyalella* (amphipod) 28-day test will be used to evaluate the toxicity of whole sediments. This test will be performed in accordance with USEPA guidance.
15. North Station Site-Specific Volatile Organic COPC list for Vapor Intrusion includes: 1,1,1-Trichloroethane, 1,1,2,2-Tetrachloroethane, 1,1-Dichloroethane, 1,1-Dichloroethene, 2-Hexanone, 4-Methyl-2-pentanone, Acetone, Bromodichloromethane, Bromomethane, Carbon disulfide, Chloroethane, Chloroform, Chloromethane, Methyl ethyl ketone, Methylene chloride and Styrene.
16. PAHs include these 17: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, chrysene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene, and 2-methylnaphthalene.
17. PVOCs include benzene, ethylbenzene, toluene, xylenes (total), 1,3,5-trimehtylbenzene, and 1,2,4-trimethylbenzene.
18. One liter summa canister will be used unless otherwise specified by laboratory to meet detection limit requirements.
19. Subsurface soil samples from 6-24" bgs will be collected only at locations where true surface soil samples are collected (i.e. no surface cover is present).
20. Subsurface soil samples will be collected from intervals where impacts are observed (visible impact, odor, PID response). If no impacts are observed, the sample will be collected at the base of the fill layer.
21. The sump will not be sampled quarterly. Instead, it will be sampled concurrent with vapor sampling inside Building 1. It is expected that the sump water will be sampled twice.

COPC - Constituent of potential concern
FS - Feasibility study
HHRA - Human health risk assessment
LOI - Loss on ignition
PAH - Polycyclic aromatic hydrocarbon
PCB - Polychlorinated biphenyl
PID - Photo-ionization detector
PVOC - Petroleum VOC
ROW - Right-of-way
TCL - Target compound list
VOC - Volatile organic compound

Table 3 - Boring, Probe, and Monitoring Well Plan
North Station Operable Unit
Kingsbury and Hobbie Streets, Chicago, Illinois
USEPA ILD982074775

Sample ID	Approximate Grade (CCD)[1]	Estimated Water Table (ft bgs)	Soil Sampling				Monitoring Wells Installed/ Groundwater Sampling		
			# Surface (0-6 inches bgs) or Near-Surface (below cover) Soil Samples	# Surface Soil Samples (6-24 inches bgs)	# Subsurface Soil Samples (>2 ft bgs)	Estimateded Boring Depth (ft bgs)[2]	Piezometer Screen Interval (ft bgs)	Total Depth of Water Table Well (ft bgs)	Estimated Water Table Well Screen Interval (ft bgs)[3]
ComEd Parcel									
MW116	12.5	5	1*	1 per every 2 true surface (0-6 inch bgs) samples	up to 2	10	NA	10	4-10
SS104	12.5	**5**	1*		--	1**	--	--	--
SS105	13.0	5	1*		--	1**	--	--	--
SS106	12.5	5	1*		--	1**	--	--	--
SS107	12.5	5	1*		--	1**	--	--	--
SS108	12.5	5	1*		--	1**	--	--	--
SS109	13.0	5	1*		--	1**	--	--	--
SS110	13.5	5	1*		--	1**	--	--	--
SS111	13.0	5	1*		--	1**	--	--	--
SS112	12.5	5	1*		--	1**	--	--	--
SS113	13.0	5	1*		--	1**	--	--	--
SG1[HS]	13.0	5	--	--	--	--	--	--	--
SG2[HS]	13.0	5	--	--	--	--	--	--	--
SG3	13.5	5	--	--	up to 2	4-6	--	--	--
SU1	13.5	5	--	--	--	--	--	--	--
LaSalle Chestnut Parcel									
MW108	12.0	5	1*	1 per every 2 true surface (0-6 inch bgs) samples	up to 2	25	15-25	10	4-10
MW109	10.5	5	1*		up to 2	25	15-25	10	4-10
MW110	12.0	5	1*		up to 2	31	21-31	16	6-16
MW111	12.0	5	1*		up to 2	25	15-25	10	4-10
Halsted Parcel									
MW112	11.0	5	1*	1 per every 2 true surface (0-6 inch bgs) samples	up to 2	25	15-25	10	4-10
MW113	11.0	5	1*		up to 2	25	15-25	10	4-10

Sample ID	Approximate Grade (CCD)[1]	Estimated Water Table (ft bgs)	Soil Sampling				Monitoring Wells Installed/ Groundwater Sampling		
			# Surface (0-6 inches bgs) or Near-Surface (below cover) Soil Samples	# Surface Soil Samples (6-24 inches bgs)	# Subsurface Soil Samples (>2 ft bgs)	Estimateded Boring Depth (ft bgs)[2]	Piezometer Screen Interval (ft bgs)	Total Depth of Water Table Well (ft bgs)	Estimated Water Table Well Screen Interval (ft bgs)[3]
Old Town Village West Parcel									
SB104	12.0	5	1***	1 per every 2 true surface (0-6 inch bgs) samples	up to 2	10	--	--	--
SB105	12.0	5	1***		up to 2	10	--	--	--
SG17	12	5	--	--	1	4-5	--	--	--
SG18	12	5	--	--	1	4-5	--	--	--
Division Parcel									
MW101	12.5	5	1*	1 per every 2 true surface (0-6 inch bgs) samples	up to 2	21	11-21	6	3-6
SB101	13.0	5	1*		up to 2	20	--	--	--
SB102	12.5	5	1*		up to 2	20	--	--	--
SB103	12.0	5	1*		up to 2	20	--	--	--
SG4	12.5	5	1*	--	up to 2	--	--	--	--
SG5	13.0	5	1*	--	up to 2	--	--	--	--
SG6	12.5	5	1*	--	up to 2	--	--	--	--
SG7	12.5	5	1*	--	up to 2	--	--	--	--
Kingsbury/Hobbie/Crosby Streets Right-of-Ways									
MW102	12.5	5	1*	1 per every 2 true surface (0-6 inch bgs) samples	up to 2	7	NA	7	4-7
MW103	12.0	5	1*		up to 2	25	15-25	10	4-10
MW104	12.0	5	1*		up to 2	8	NA	8	3-8
MW105	12.0	5	1*		up to 2	23	13-23	8	3-8
MW106	13.0	5	1*		up to 2	21	11-21	6	3-6
MW107	12.5	5	1*		up to 2	23	13-23	8	3-8
MW114	12.5	5	1*		up to 2	23	13-23	8	3-8
MW115	13.0	5	1*		up to 2	23	13-23	8	3-8
SG8	12.0	5	--	--	up to 2	--	--	--	--
SG9	12.0	5	--	--	up to 2	--	--	--	--
SG10	12.0	5	--	--	up to 2	--	--	--	--
SG11	12.0	5	--	--	up to 2	--	--	--	--
SG12	12.0	5	--	--	up to 2	--	--	--	--
SG13	12.0	5	--	--	up to 2	--	--	--	--
SG14	13.0	5	--	--	up to 2	--	--	--	--
SG15	13.0	5	--	--	up to 2	--	--	--	--

Notes:
One subsurface soil sample assumed for locations where subsurface soil will be collected. Two samples may be collected per the SSWP.
* If boring location is covered in pavement, gravel, or surface fill, it may be necessary to collect a near-surface sample (0-6 inches below cover) instead of a true surface soil sample.
** Assuming 6 inches of gravel cover at ComEd parcel, sample will be collected from near-surface, at 0-6 inches below the cover.
*** Assuming 18 inches of topsoil and compacted clay cover at Old Town Village West parcel, sample will be collected from near-surface, at 0-6 inches below the compacted clay cover.
^{HS} Samples are sump headspace samples, not soil gas probes.
1) Chicago City Datum
2) Depths are estimated. For samples other than the ComEd surface only samples, drilling will continue until 4 feet below visual or PID impacts and native clay is
3) 10-foot screens to be installed according to SOP SAS-05-03 from the Multi-Site FSP. Screen intervals are estimated and will change based on total well depth, which may vary based on depth to native clay or potential impacts encountered.
bgs - Below ground surface
ft - Feet

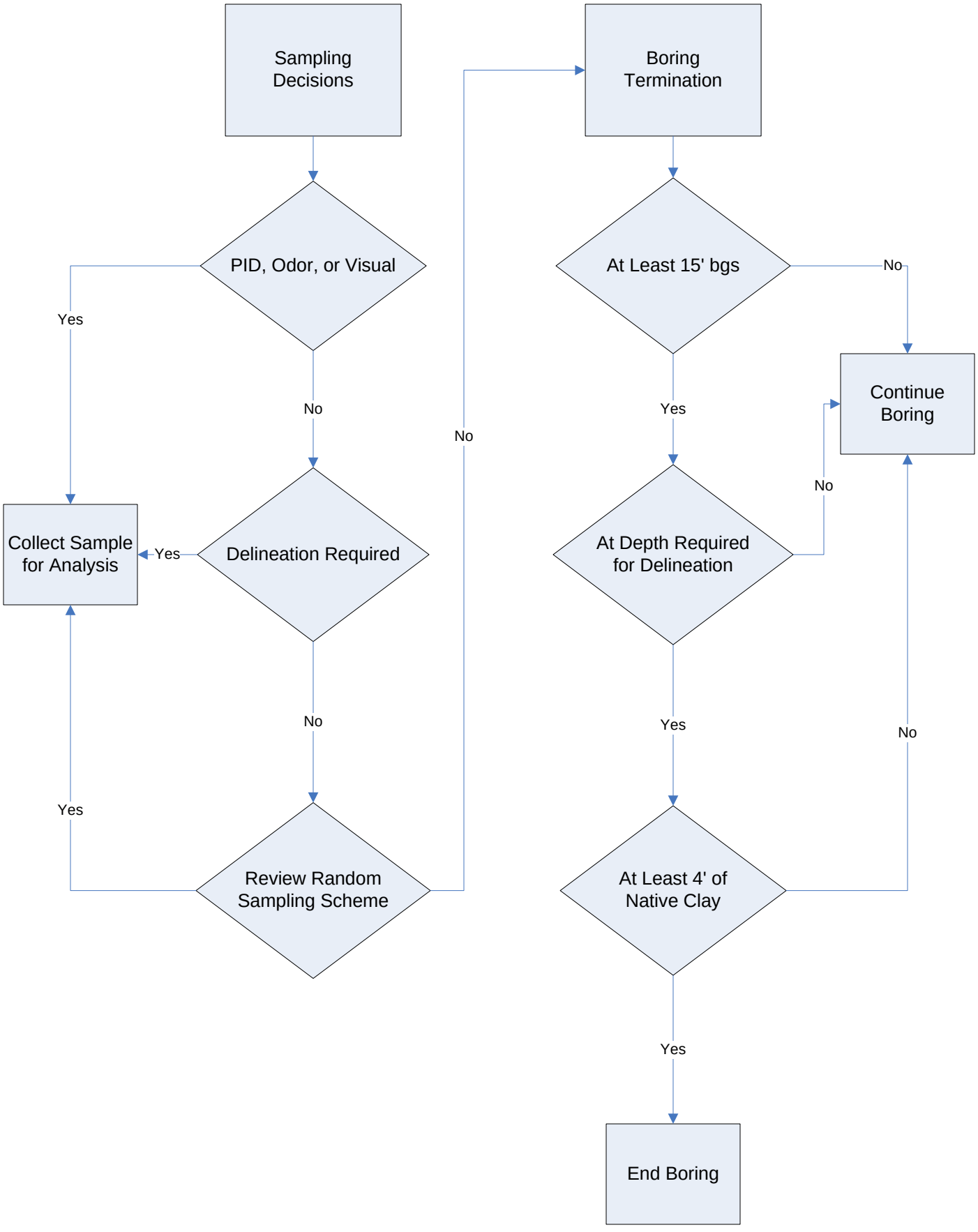

Table 4 – Site-Specific Decision Tree for Soil Borings and Sampling		
North Station OU - SSWP	August 2011	Rev.0

APPENDIX A

HISTORICAL SITE DOCUMENTATION

APPENDIX A1

HISTORICAL SITE MAPS
(INCLUDED ON CD)

North Station
1127 Halsted
Chicago, IL 60610

Inquiry Number: 3066595.3
May 12, 2011

Certified Sanborn® Map Report

EDR® Environmental Data Resources Inc

440 Wheelers Farms Road
Milford, CT 06461
800.352.0050
www.edrnet.com

Certified Sanborn® Map Report

5/12/11

Site Name:
North Station
1127 Halsted
Chicago, IL 60610

Client Name:
Natural Resource Technology
23713 W. Paul Road
Pewaukee, WI 53072

EDR Inquiry # 3066595.3

Contact: Robert Karnauskas

EDR® Environmental Data Resources Inc

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Certified Sanborn Results:

Site Name: North Station
Address: 1127 Halsted
City, State, Zip: Chicago, IL 60610
Cross Street:
P.O. # NA
Project: 2034
Certification # DC7D-4CAF-9F4F

Maps Provided:

2004	1935
2002	1910
1990	
1988	
1975	
1950	

Sanborn® Library search results
Certification # DC7D-4CAF-9F4F

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- ☑ University Publications of America
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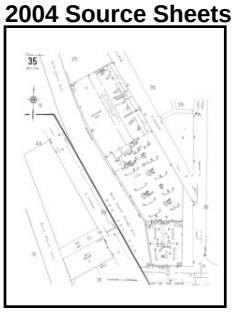
Sanborn Sheet Thumbnails

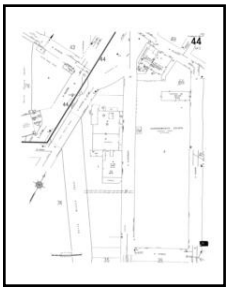
This Certified Sanborn Map Report is based upon the following Sanborn Fire Insurance map sheets.

2004 Source Sheets



Volume 2S, Sheet 35

Volume 2S, Sheet 39



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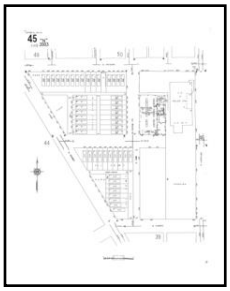

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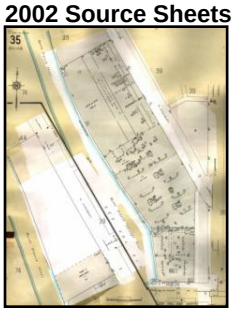
2002 Source Sheets



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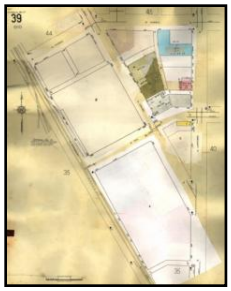

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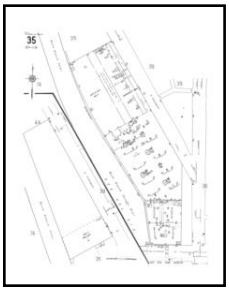

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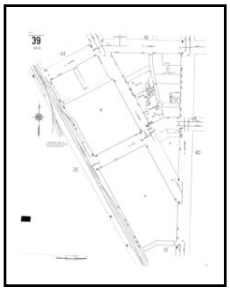

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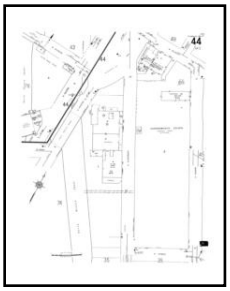

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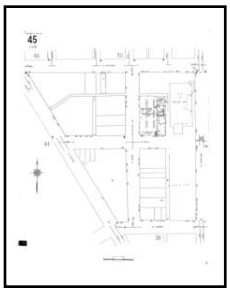

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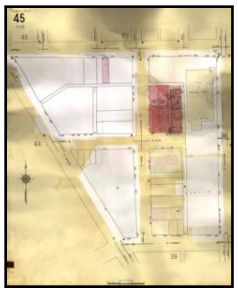

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1990 Source Sheets

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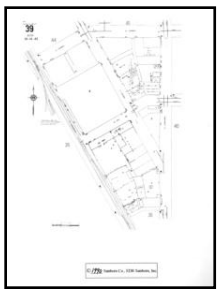
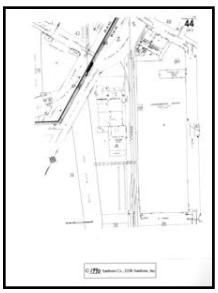
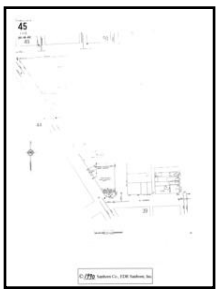


Volume 2S, Sheet 39

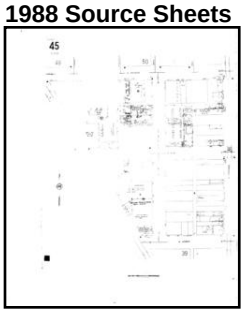


Volume 2S, Sheet 44



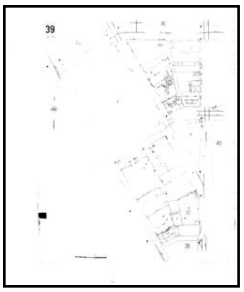
Volume 2S, Sheet 45

1988 Source Sheets



Volume 2S, Sheet 45

Volume 2S, Sheet 35



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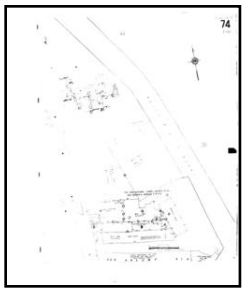

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1975 Source Sheets

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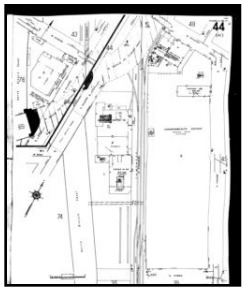

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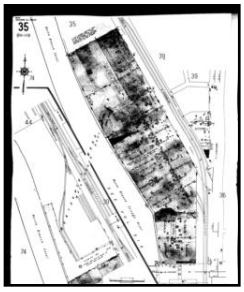
Volume 2S, Sheet 45



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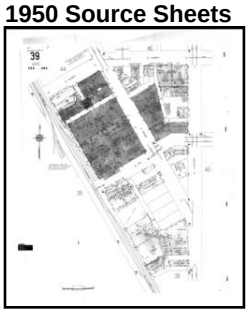
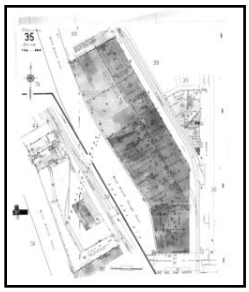
1950 Source Sheets



Volume 2S, Sheet 39



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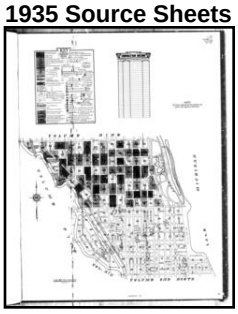
1935 Source Sheets



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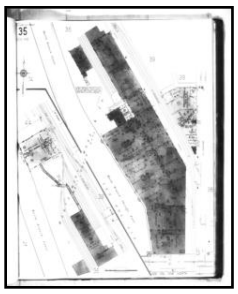

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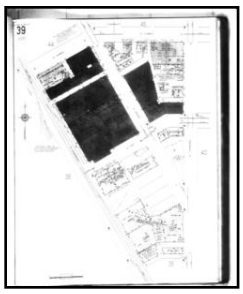

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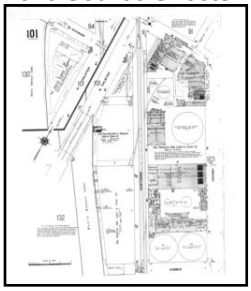
1910 Source Sheets



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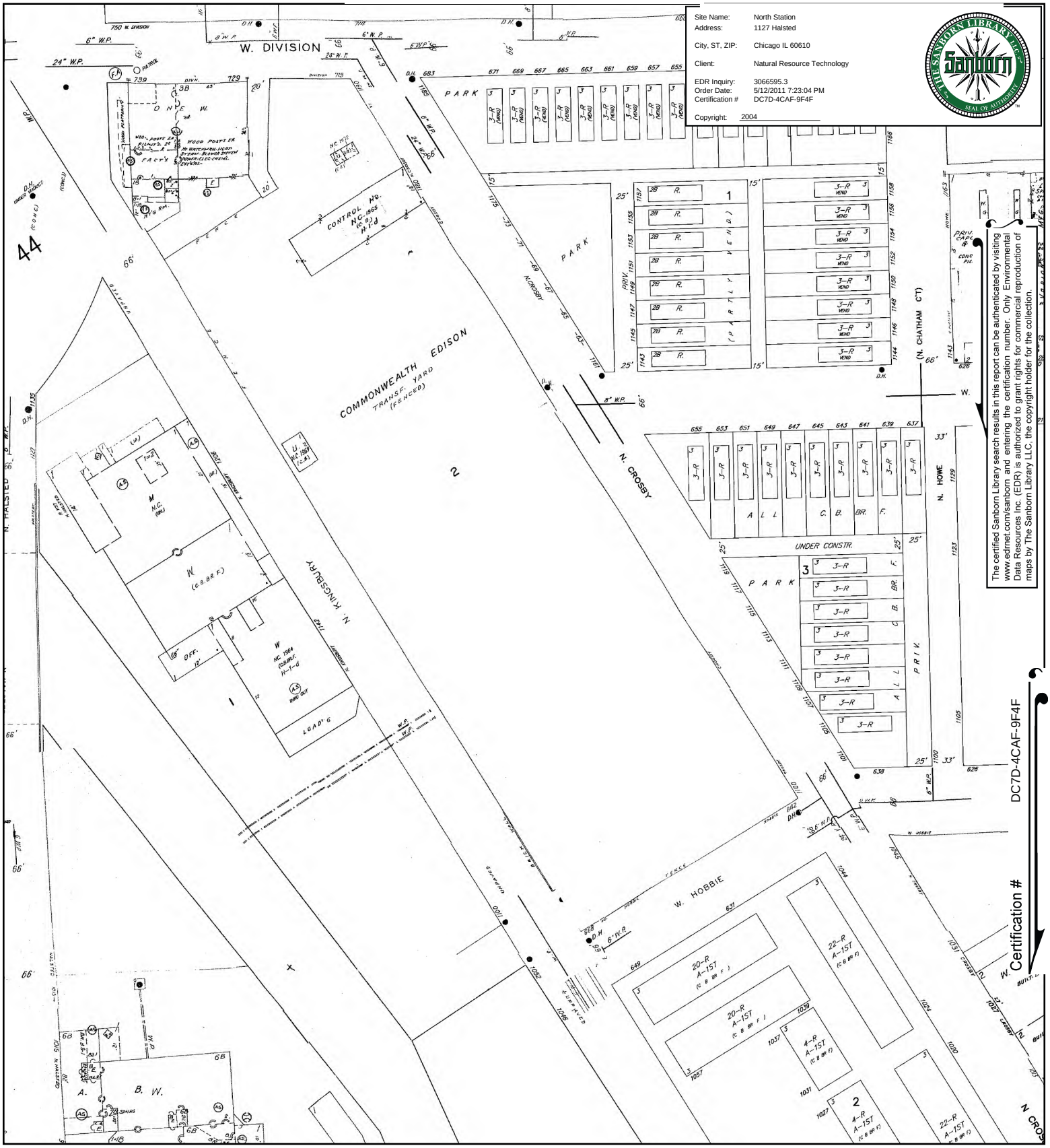
2004 Certified Sanborn Map



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Outlined areas indicate map sheets within the collection.

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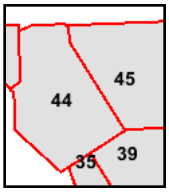

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2002 Certified Sanborn Map

Site Name: North Station
Address: 1127 Halsted
City, ST, ZIP: Chicago IL 60610
Client: Natural Resource Technology
EDR Inquiry: 3066595.3
Order Date: 5/12/2011 7:23:04 PM
Certification #: DC7D-4CAF-9F4F
Copyright: 2002

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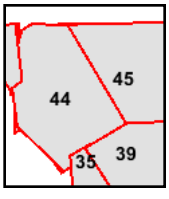

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Volume 2S, Sheet 35
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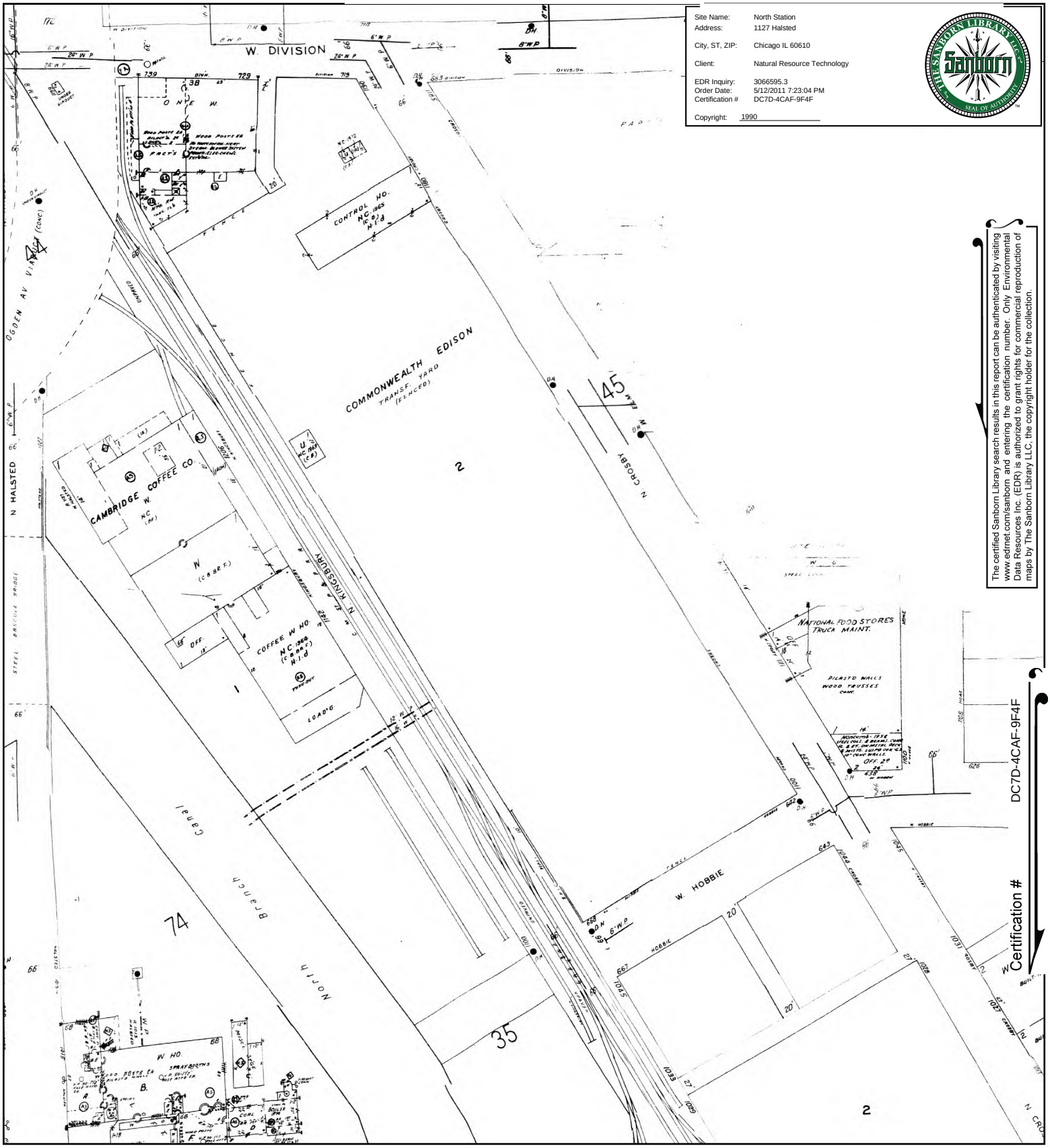
Volume 2S, Sheet 45
Volume 2S, Sheet 44

1990 Certified Sanborn Map

Site Name: North Station
Address: 1127 Halsted
City, ST, ZIP: Chicago IL 60610
Client: Natural Resource Technology
EDR Inquiry: 3066595.3
Order Date: 5/12/2011 7:23:04 PM
Certification # DC7D-4CAF-9F4F
Copyright: 1990



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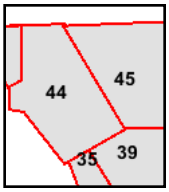

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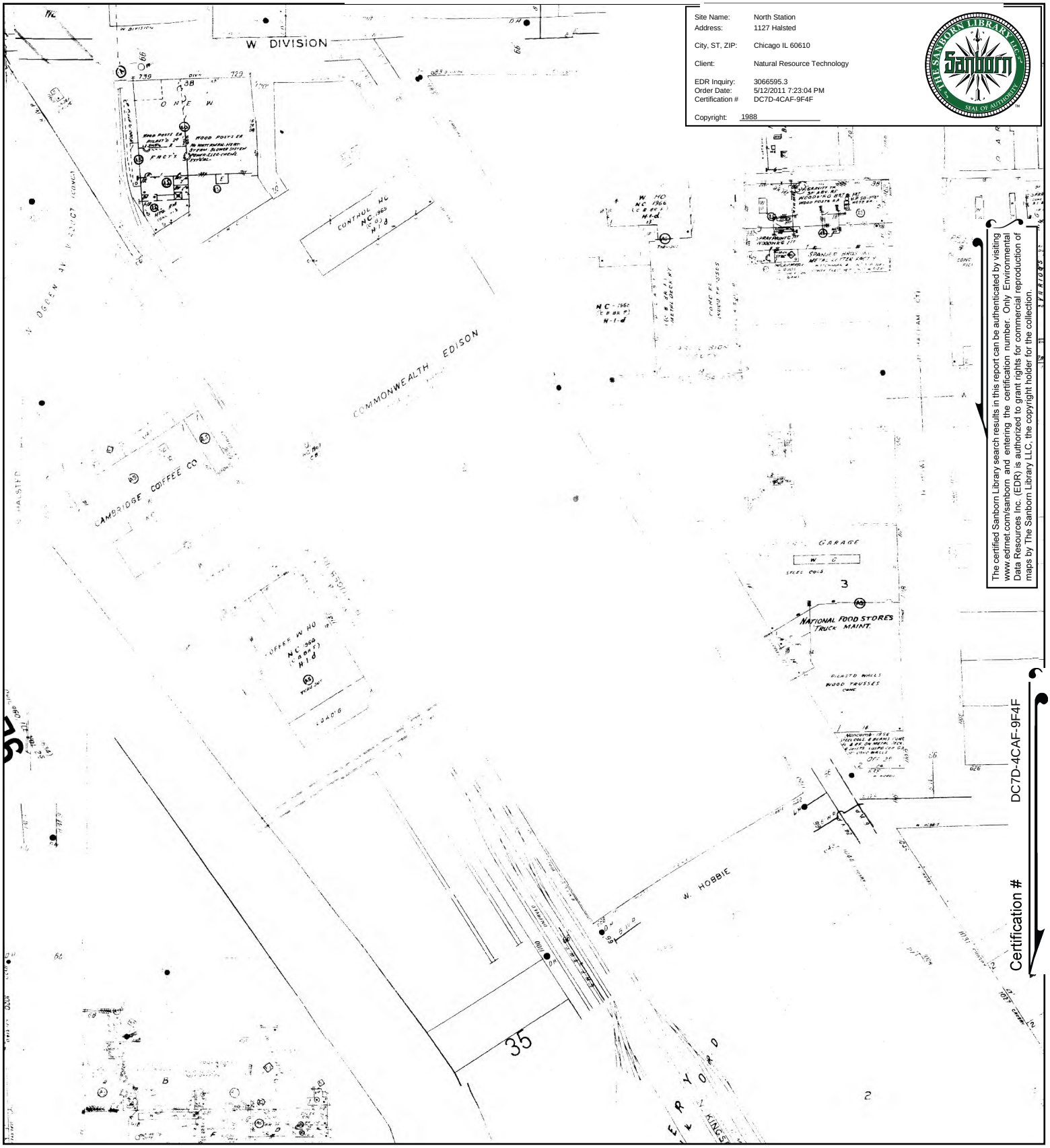
1988 Certified Sanborn Map



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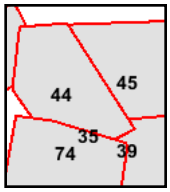

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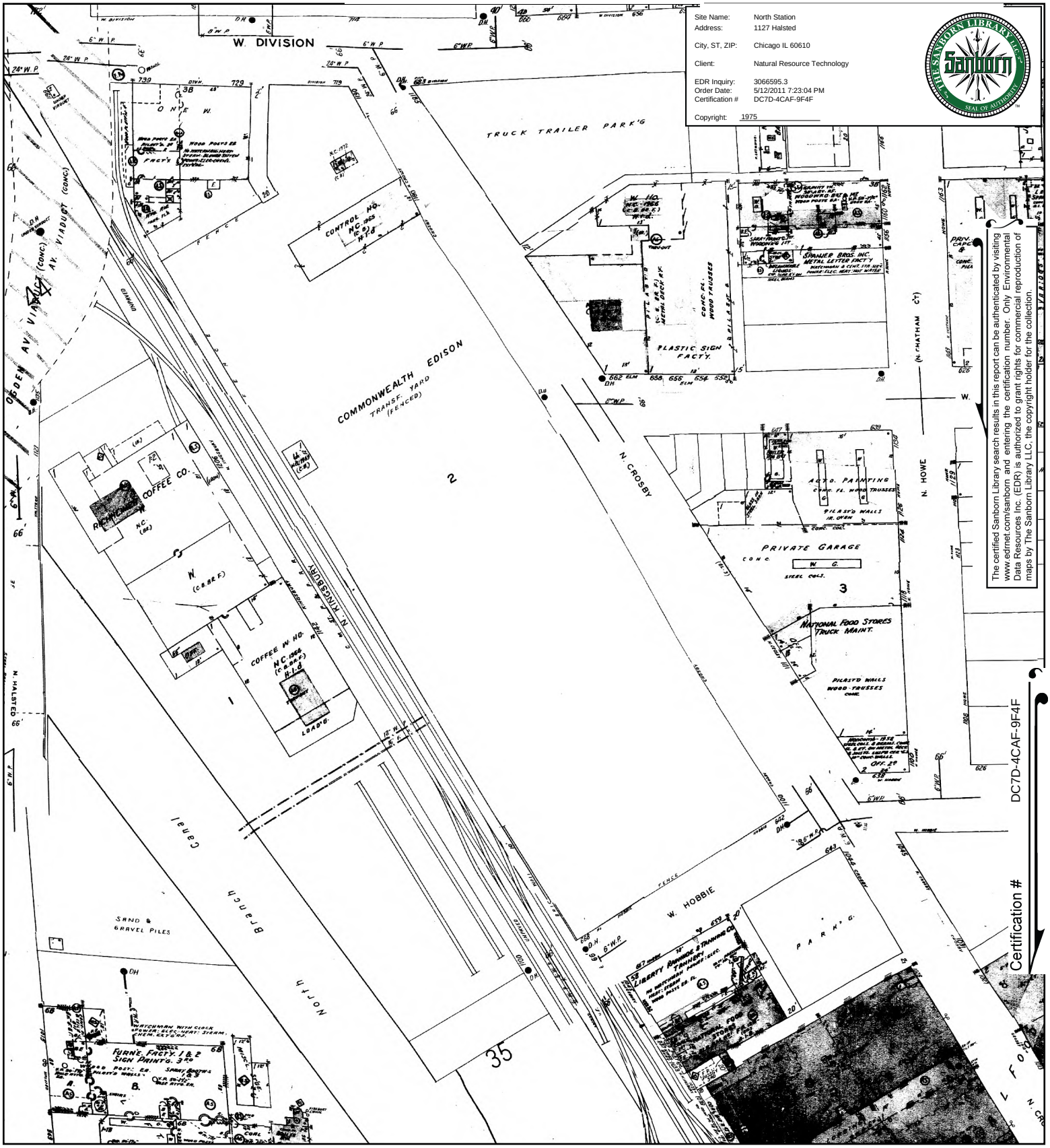
1975 Certified Sanborn Map



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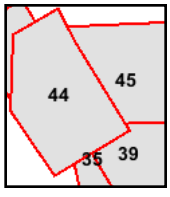

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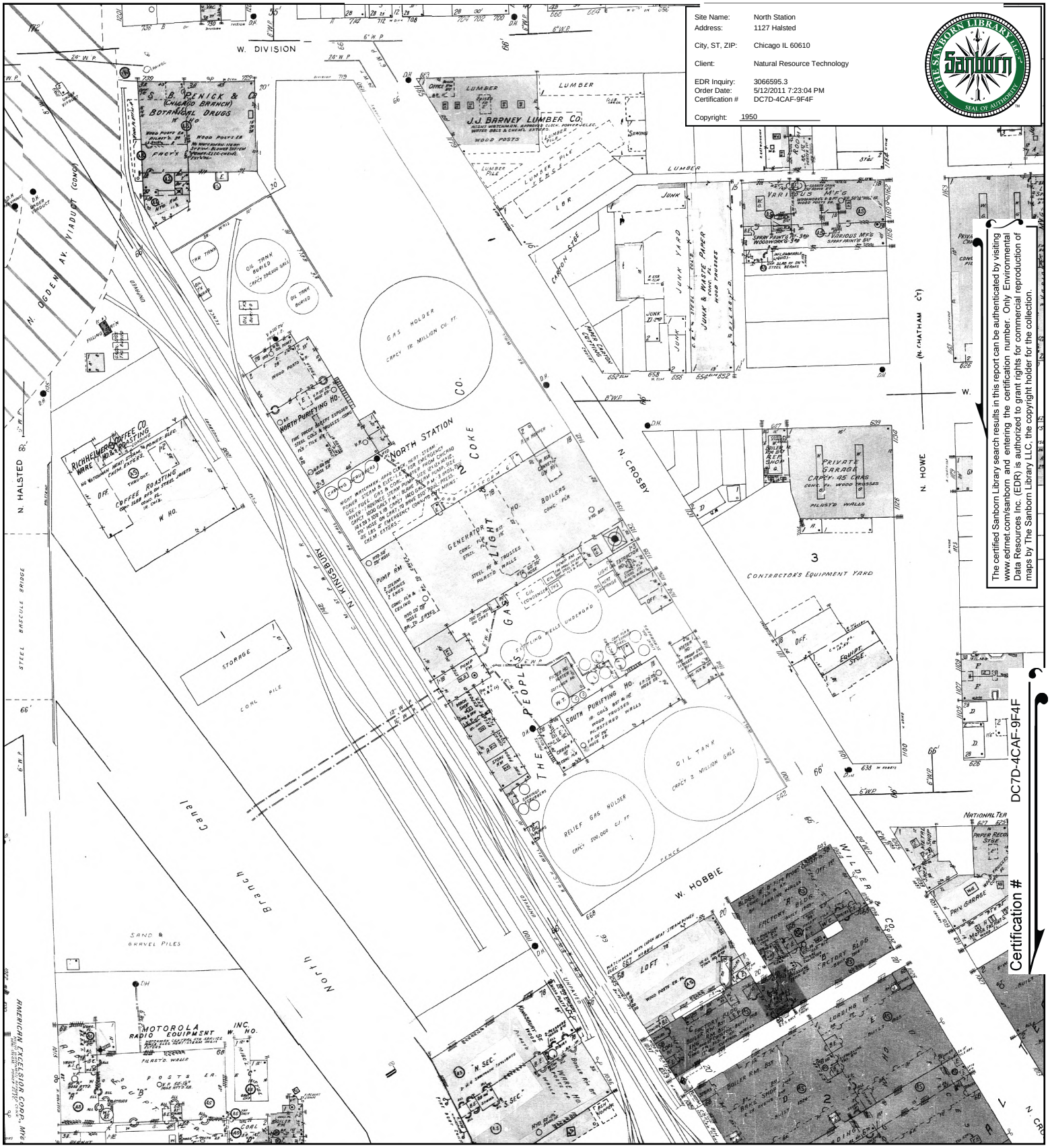
1950 Certified Sanborn Map



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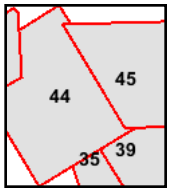

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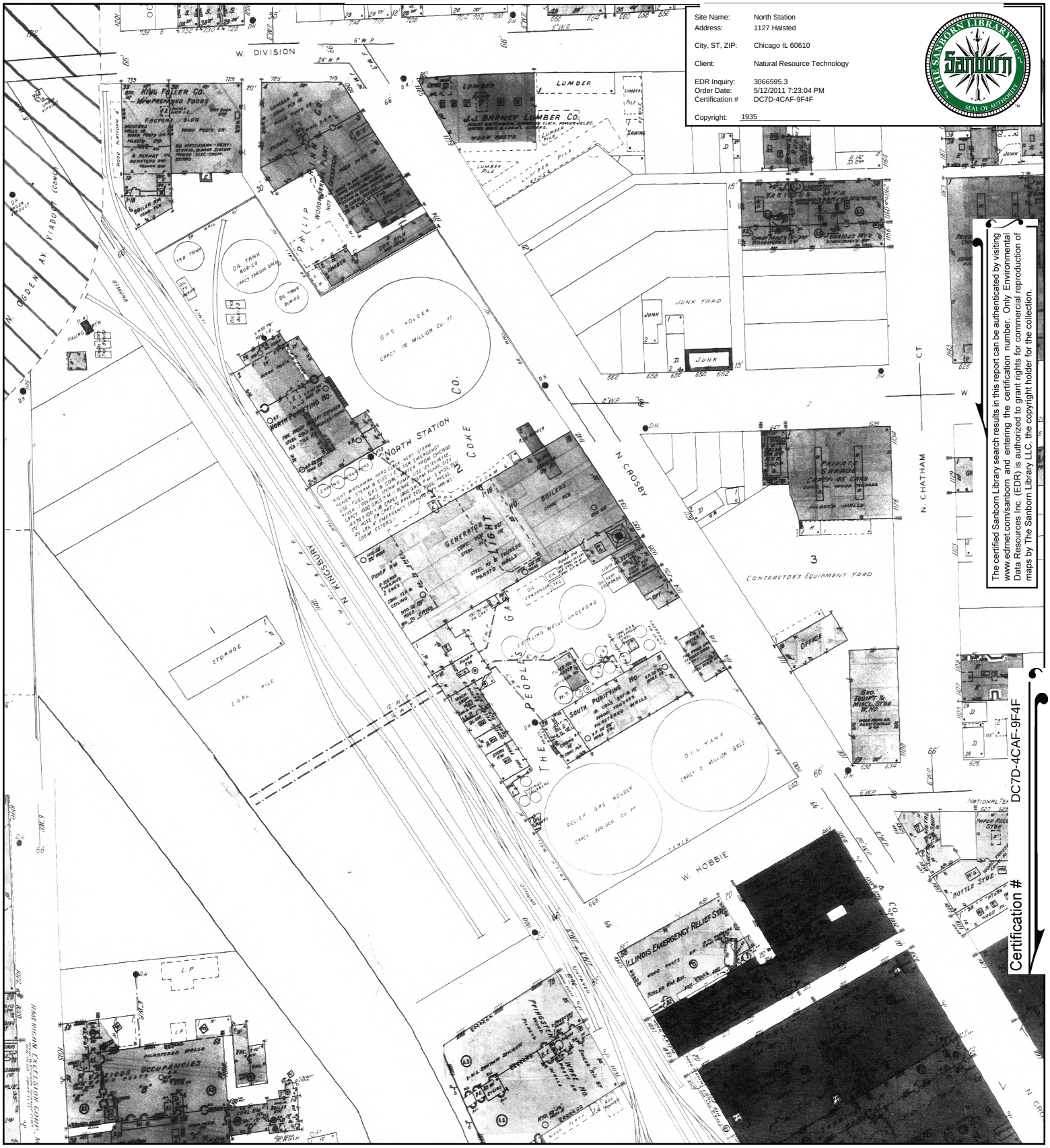
1935 Certified Sanborn Map



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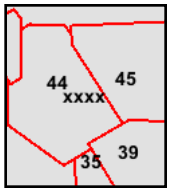

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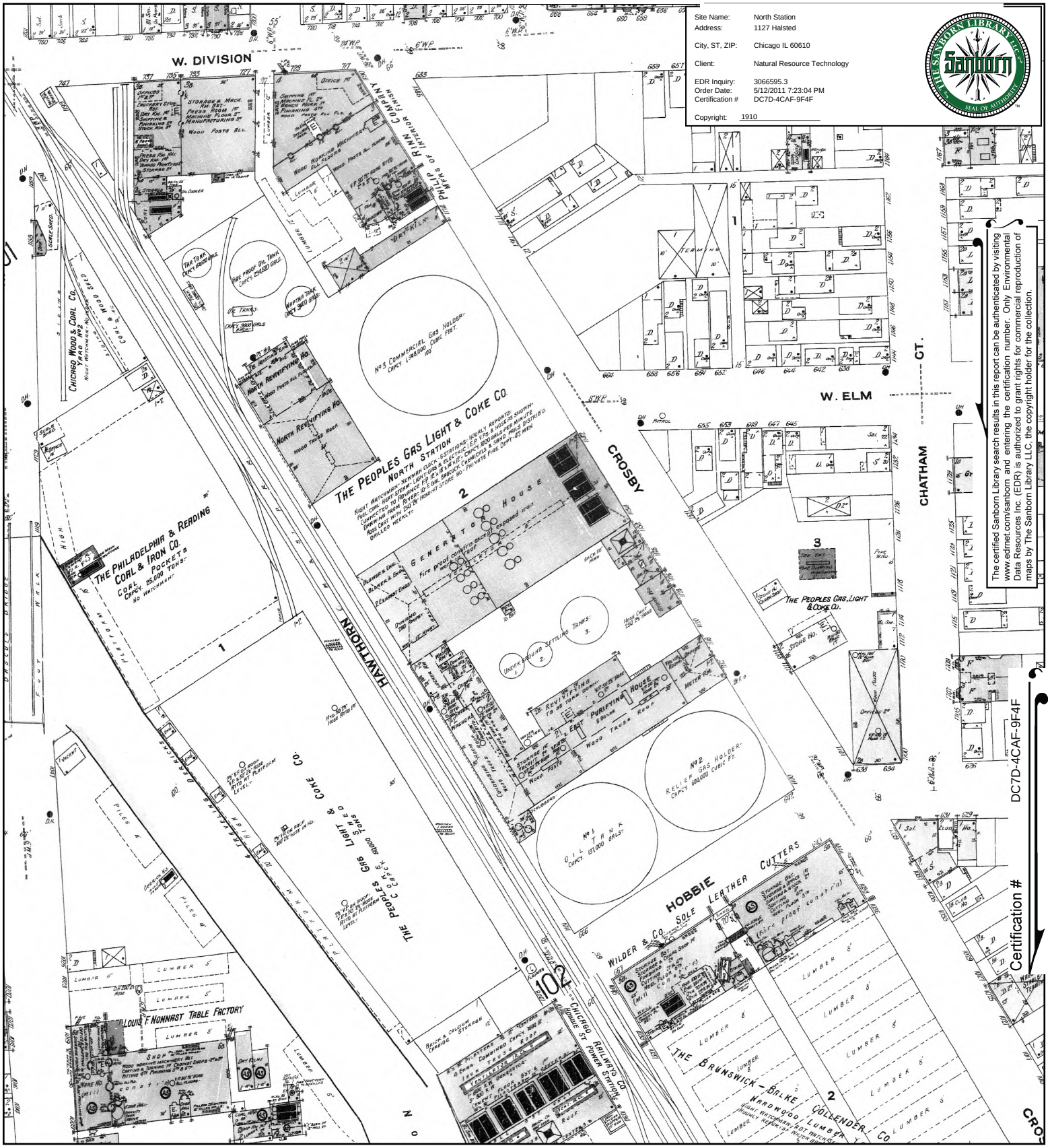
Volume 2S, Sheet 44
Volume 2S, Sheet 45
Volume 2S, Sheet 39

1910 Certified Sanborn Map

Site Name: North Station
Address: 1127 Halsted
City, ST, ZIP: Chicago IL 60610
Client: Natural Resource Technology
EDR Inquiry: 3066595.3
Order Date: 5/12/2011 7:23:04 PM
Certification #: DC7D-4CAF-9F4F
Copyright: 1910



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DC7D-4CAF-9F4F Certification #

This Certified Sanborn Map combines the following sheets.
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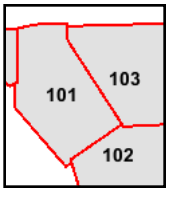

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N

APPENDIX A2

EDR RADIUS REPORT EXCERPTS
(INCLUDED ON CD)

North Station
1127 Halsted
Chicago, IL 60610

Inquiry Number: 3066595.2s
May 12, 2011

The EDR Radius Map™ Report with GeoCheck®

EDR® Environmental Data Resources Inc

440 Wheelers Farms Road
Milford, CT 06461
Toll Free: 800.352.0050
www.edrnet.com

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Detail Map	3
Map Findings Summary	4
Map Findings	7
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Government Records Searched/Data Currency Tracking	GR-1

GEOCHECK ADDENDUM

Physical Setting Source Addendum	A-1
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Physical Setting Source Records Searched	A-58

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

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EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-05) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

TARGET PROPERTY INFORMATION

ADDRESS

1127 HALSTED
CHICAGO, IL 60610

COORDINATES

Latitude (North):	41.902100 - 41° 54' 7.6''
Longitude (West):	87.646000 - 87° 38' 45.6''
Universal Tranverse Mercator:	Zone 16
UTM X (Meters):	446416.3
UTM Y (Meters):	4638895.0
Elevation:	585 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property Map:	41087-H6 CHICAGO LOOP, IL
Most Recent Revision:	1997

AERIAL PHOTOGRAPHY IN THIS REPORT

Portions of Photo from:	2005, 2006, 2007
Source:	USDA

TARGET PROPERTY SEARCH RESULTS

The target property was identified in the following records. For more information on this property see page 7 of the attached EDR Radius Map report:

Site	Database(s)	EPA ID
DIVISION-HALSTED LLC 1111-1127 N HALSTED ST CHICAGO, IL 60622	FINDS	N/A
OLD RICH HEIMER COFFEE CO. 1111-1127 NORTH HALSTED CHICAGO, IL 60622	UST	N/A
DIVISION-HALSTED LLC 1111-27 NORTH HALSTED STREET CHICAGO, IL 60622	LUST NFA/NFR Letter: 06/24/2005	N/A
DIVISION-HALSTED LLC 1111-1127 N HALSTED ST CHICAGO, IL	AIRS	N/A

EXECUTIVE SUMMARY

RICHHEIMER COFFEE COMPANY
1127 NORTH HALSTED STREET
CHICAGO, IL 60622

FINDS

N/A

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the search radius around the target property for the following databases:

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL ---------- National Priority List
Proposed NPL ---------- Proposed National Priority List Sites
NPL LIENS ---------- Federal Superfund Liens

Federal Delisted NPL site list

Delisted NPL ---------- National Priority List Deletions

Federal CERCLIS list

FEDERAL FACILITY ---------- Federal Facility Site Information listing

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF ---------- RCRA - Treatment, Storage and Disposal

Federal institutional controls / engineering controls registries

US ENG CONTROLS ---------- Engineering Controls Sites List
US INST CONTROL ---------- Sites with Institutional Controls

Federal ERNS list

ERNS ---------- Emergency Response Notification System

State- and tribal - equivalent CERCLIS

SSU ---------- State Sites Unit Listing

State and tribal landfill and/or solid waste disposal site lists

LF SPECIAL WASTE ---------- Special Waste Site List
IL NIPC ---------- Solid Waste Landfill Inventory
CCDD ---------- Clean Construction or Demolition Debris

State and tribal leaking storage tank lists

LUST TRUST ---------- Underground Storage Tank Fund Payment Priority List

INDIAN LUST ---- Leaking Underground Storage Tanks on Indian Land

State and tribal registered storage tank lists

INDIAN UST ---- Underground Storage Tanks on Indian Land
FEMA UST ---- Underground Storage Tank Listing

State and tribal voluntary cleanup sites

INDIAN VCP ---- Voluntary Cleanup Priority Listing

State and tribal Brownfields sites

BROWNFIELDS ---- Municipal Brownfields Redevelopment Grant Program Project Descriptions

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS ---- A Listing of Brownfields Sites

Local Lists of Landfill / Solid Waste Disposal Sites

ODI ---- Open Dump Inventory
DEBRIS REGION 9 ---- Torres Martinez Reservation Illegal Dump Site Locations
INDIAN ODI ---- Report on the Status of Open Dumps on Indian Lands

Local Lists of Hazardous waste / Contaminated Sites

US CDL ---- Clandestine Drug Labs
CDL ---- Meth Drug Lab Site Listing
US HIST CDL ---- National Clandestine Laboratory Register

Local Land Records

LIENS 2 ---- CERCLA Lien Information
LUCIS ---- Land Use Control Information System

Records of Emergency Release Reports

HMIRS ---- Hazardous Materials Information Reporting System
SPILLS ---- State spills

Other Ascertainable Records

DOT OPS ---- Incident and Accident Data
DOD ---- Department of Defense Sites
FUDS ---- Formerly Used Defense Sites
CONSENT ---- Superfund (CERCLA) Consent Decrees
ROD ---- Records Of Decision
UMTRA ---- Uranium Mill Tailings Sites
TRIS ---- Toxic Chemical Release Inventory System
TSCA ---- Toxic Substances Control Act
FTTS ---- FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

HIST FTTS	FIFRA/TSCA Tracking System Administrative Case Listing
SSTS	Section 7 Tracking Systems
ICIS	Integrated Compliance Information System
PADS	PCB Activity Database System
MLTS	Material Licensing Tracking System
RADINFO	Radiation Information Database
RAATS	RCRA Administrative Action Tracking System
UIC	Underground Injection Wells
NPDES	A Listing of Active Permits
DRYCLEANERS	Illinois Licensed Drycleaners
IMPDMENT	Surface Impoundment Inventory
TIER 2	Tier 2 Information Listing
INDIAN RESERV	Indian Reservations
SCRD DRYCLEANERS	State Coalition for Remediation of Drycleaners Listing
PCB TRANSFORMER	PCB Transformer Registration Database
COAL ASH EPA	Coal Combustion Residues Surface Impoundments List
COAL ASH DOE	Sleam-Electric Plan Operation Data
PIMW	Potentially Infectious Medical Waste
FINANCIAL ASSURANCE	Financial Assurance Information Listing

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified in the following databases.

Elevations have been determined from the USGS Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property.
Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

STANDARD ENVIRONMENTAL RECORDS

Federal CERCLIS list

CERCLIS: The Comprehensive Environmental Response, Compensation and Liability Information System contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

A review of the CERCLIS list, as provided by EDR, and dated 02/25/2011 has revealed that there is 1 CERCLIS site within approximately 0.5 miles of the target property.

Lower Elevation	Address	Direction / Distance	Map ID	Page
PEOPLES GAS LIGHT & COKE NORTH	***N. CROSBY & W. DIVISION***	***0 - 1/8 (0.001 mi.)***	***C10***	***13***

EXECUTIVE SUMMARY

Federal CERCLIS NFRAP site List

CERC-NFRAP: Archived sites are sites that have been removed and archived from the inventory of CERCLIS sites. Archived status indicates that, to the best of EPA's knowledge, assessment at a site has been completed and that EPA has determined no further steps will be taken to list this site on the National Priorities List (NPL), unless information indicates this decision was not appropriate or other considerations require a recommendation for listing at a later time. This decision does not necessarily mean that there is no hazard associated with a given site; it only means that, based upon available information, the location is not judged to be a potential NPL site.

A review of the CERC-NFRAP list, as provided by EDR, and dated 02/25/2011 has revealed that there are 5 CERC-NFRAP sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
COMMONWEALTH EDISON NORTH STA	1122 N CROSBY ST	0 - 1/8 (0.000 mi.)	A8	11
DEVOL & RAYNOLDS	***800-808 WEST SUPERIOR S***	***S 1/4 - 1/2 (0.355 mi.)***	***106***	***203***
RIVER WEST PLAZA	***770 N HALSTED***	***SSW 1/4 - 1/2 (0.428 mi.)***	***AD124***	***219***
RAYMOND LEAD CO	940-944 WEST HURON STRE	SSW 1/4 - 1/2 (0.460 mi.)	AL137	233

Lower Elevation	Address	Direction / Distance	Map ID	Page
STIFFEL CO	***700 N. KINGSBURY ST.***	***SSE 1/4 - 1/2 (0.258 mi.)***	***U85***	***170***

Federal RCRA CORRACTS facilities list

CORRACTS: CORRACTS is a list of handlers with RCRA Corrective Action Activity. This report shows which nationally-defined corrective action core events have occurred for every handler that has had corrective action activity.

A review of the CORRACTS list, as provided by EDR, and dated 05/25/2010 has revealed that there are 3 CORRACTS sites within approximately 1 mile of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
TRUE VALUE MFG CO	***823 W BLACKHAWK AVE***	***N 1/4 - 1/2 (0.335 mi.)***	***Z103***	***195***
LISSNER CORP	***1000 N OGDEN AVE***	***SW 1/4 - 1/2 (0.357 mi.)***	***X107***	***204***
ELKWOOD PLATING INCORPORATED	***1657 NORTH ELSTON AVENU***	***NW 1/2 - 1 (0.922 mi.)***	***151***	***244***

Federal RCRA generators list

RCRA-LQG: RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Large quantity generators (LQGs) generate over 1,000 kilograms (kg) of hazardous waste, or over 1 kg of acutely hazardous waste per month.

A review of the RCRA-LQG list, as provided by EDR, and dated 03/11/2011 has revealed that there is 1 RCRA-LQG site within approximately 0.25 miles of the target property.

Lower Elevation	Address	Direction / Distance	Map ID	Page
NAZDAR CO	***1087 N NORTH BRANCH ST***	***SW 1/8 - 1/4 (0.246 mi.)***	***S79***	***152***

RCRA-SQG: RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Small quantity generators (SQGs) generate between 100 kg and 1,000 kg of hazardous waste per month.

A review of the RCRA-SQG list, as provided by EDR, and dated 03/11/2011 has revealed that there are 9 RCRA-SQG sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
CENTERMARK GRAPHICS	***1333 N KINGSBURY STE 20***	***N 0 - 1/8 (0.092 mi.)***	***34***	***46***
GOOSE ISLAND BOAT YARD	934 N NORTH BRANCH ST	SW 1/8 - 1/4 (0.144 mi.)	K48	87

Lower Elevation	Address	Direction / Distance	Map ID	Page
DIGITAL HUB	1040 N HALSTED ST	SW 0 - 1/8 (0.030 mi.)	14	19
FEDERAL EXPRESS CORP	***875 W DIVISION***	***W 0 - 1/8 (0.061 mi.)***	***F18***	***25***
STUART DEAN CO INC	***870 W DIVISION ST STE***	***W 0 - 1/8 (0.072 mi.)***	***F23***	***35***
GREYHOUND LINES INC	***901 N HALSTED***	***SW 0 - 1/8 (0.103 mi.)***	***H37***	***68***
GOLD COAST AUTO BODY INC	***900 W DIVISION***	***W 0 - 1/8 (0.120 mi.)***	***I39***	***76***
COM ED	DIVISION & HICKORY	W 1/8 - 1/4 (0.166 mi.)	I56	121
REPUBLIC WINDOWS AND DOORS	***926 W EVERGREEN***	***WNW 1/8 - 1/4 (0.183 mi.)***	***59***	***125***

RCRA-CESQG: RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Conditionally exempt small quantity generators (CESQGs) generate less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month.

A review of the RCRA-CESQG list, as provided by EDR, and dated 03/11/2011 has revealed that there are 6 RCRA-CESQG sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
CITY OF CHICAGO/ABANDONED PROP	***1200 N HALSTED ST***	***N 0 - 1/8 (0.002 mi.)***	***B12***	***17***
CITY OF CHICAGO/ABANDONED PROP	***1160 N HOWE ST***	***ENE 0 - 1/8 (0.081 mi.)***	***D27***	***38***
FREDRICK VON SCHILLER	640 W SCOTT ST	NE 1/8 - 1/4 (0.146 mi.)	L51	89
JENNER EDWARD ACAD OF THE ARTS	1009 N CLEVELAND AVE	ESE 1/8 - 1/4 (0.189 mi.)	N63	130

Lower Elevation	Address	Direction / Distance	Map ID	Page
CHICAGO TRANSIT AUTHORITY	***901 W DIVISION ST***	***W 0 - 1/8 (0.085 mi.)***	***F30***	***42***
MW-CPAGMW/CPAG HOLDINGS LLC	***900 N KINGSBURY***	***SSE 1/8 - 1/4 (0.195 mi.)***	***O67***	***138***

State and tribal landfill and/or solid waste disposal site lists

SWF/LF: The Solid Waste Facilities/Landfill Sites records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. The data come from the Illinois Environmental Protection Agency's Available Disposal for Solid Waste in Illinois--Solid Waste Landfills Subject to State Surcharge list.

A review of the SWF/LF list, as provided by EDR, and dated 12/31/2008 has revealed that there is 1

SWF/LF site within approximately 0.5 miles of the target property.

Lower Elevation	Address	Direction / Distance	Map ID	Page
HOOKER STREET TRANSFER STATION	1500 N. HOOKER ST.	NW 1/4 - 1/2 (0.360 mi.)	108	206

State and tribal leaking storage tank lists

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the Illinois Environmental Protection Agency's LUST Incident Report.

A review of the LUST list, as provided by EDR, and dated 03/03/2011 has revealed that there are 56 LUST sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
HUSSAIN, ZAFAR	1234 NORTH HALSTEAD	N 0 - 1/8 (0.015 mi.)	B13	18
SPANJER BROTHERS INC.	1155 NORTH HOWE	ENE 0 - 1/8 (0.080 mi.)	D25	37
NFA/NFR Letter: 09/07/1993				
RIVER WORKS LLC	926 NORTH NORTH BRANCH	SW 1/8 - 1/4 (0.140 mi.)	H45	84
NFA/NFR Letter: 05/03/1999				
CHICAGO PUBLIC SCHOOLS	640 WEST SCOTT	NE 1/8 - 1/4 (0.146 mi.)	L50	89
DAYTON DAWGS LLC	1400 NORTH DAYTON STREE	N 1/8 - 1/4 (0.185 mi.)	M61	129
WHITE WAY SIGN & MAINT. CO.	1409 NORTH LARRABEE	NE 1/8 - 1/4 (0.249 mi.)	T81	165
NFA/NFR Letter: 01/10/2002				
CRENSHAW, NANCY	1440 NORTH DAYTON	N 1/4 - 1/2 (0.258 mi.)	R84	170
NFA/NFR Letter: 07/24/2008				
WHITE WAY SIGN COMPANY	1317 NORTH CLYBOURN AVE	NE 1/4 - 1/2 (0.269 mi.)	W87	175
NFA/NFR Letter: 02/11/2008				
WHITE WAY SIGN CO.	1317 NORTH CLYBOURN AVE	NE 1/4 - 1/2 (0.269 mi.)	W88	176
EAST END CARTAGE	1275-1285 CLYBOURN AVE.	ENE 1/4 - 1/2 (0.280 mi.)	90	178
NFA/NFR Letter: 10/01/1996				
MICHAELSON, JULIAN	860 NORTH LESSING ST.	SW 1/4 - 1/2 (0.283 mi.)	91	179
NFA/NFR Letter: 03/10/2000				
CHICAGO TRIBUNE CO	***777 W CHICAGO AVE***	***SSW 1/4 - 1/2 (0.301 mi.)***	***94***	***181***
NFA/NFR Letter: 01/03/1994				
MATERIAL SERVICE CORP.	901 NORTH SANGAMON	SW 1/4 - 1/2 (0.328 mi.)	X96	186
NFA/NFR Letter: 12/20/2007				
NFA/NFR Letter: 06/13/2003				
**Additional key fields are available in the Map Findings section*				
PAL GROUP	901 NORTH SANGAMON	SW 1/4 - 1/2 (0.328 mi.)	X97	187
NFA/NFR Letter: 09/12/2001				
BIGANE PAVING	901 NORTH SANGAMON	SW 1/4 - 1/2 (0.328 mi.)	X98	188
NFA/NFR Letter: 03/28/2005				
CARBIT PAINT CO	***927 W. BLACKHAWK ST.***	***NNW 1/4 - 1/2 (0.333 mi.)***	***Y99***	***188***
NFA/NFR Letter: 01/22/2008				
CAR BIT PAINT CO.	927 WEST BLACKHAWK ST.	NNW 1/4 - 1/2 (0.333 mi.)	Y100	192
NFA/NFR Letter: 02/10/2009				
STRUCTURED DEVELOPMENT	823 WEST BLACKHAWK STRE	N 1/4 - 1/2 (0.335 mi.)	Z102	195
TRUE VALUE MFG CO	***823 W BLACKHAWK AVE***	***N 1/4 - 1/2 (0.335 mi.)***	***Z103***	***195***
CHICAGO HOUSING AUTHORITY	1531 WEST CLYBOURN AVE.	N 1/4 - 1/2 (0.393 mi.)	110	208

EXECUTIVE SUMMARY

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
MCL CONSTRUCTION NFA/NFR Letter: 02/02/1999	427 WEST SCOTT	ENE 1/4 - 1/2 (0.396 mi.)	AA111	208
OSCAR MAYER FOOD CORP. NFA/NFR Letter: 07/19/1996	427 WEST SCOTT ST.	ENE 1/4 - 1/2 (0.403 mi.)	AA112	209
BLACKHAWK BLDG. NFA/NFR Letter: 03/06/2006	1504 NORTH FREMONT	NNW 1/4 - 1/2 (0.406 mi.)	AB114	210
RANQUIST HOME BUILDERS NFA/NFR Letter: 05/17/2004	1024 WEST FRY STREET	SW 1/4 - 1/2 (0.413 mi.)	AC116	212
CANNON BALL COURIER SERVICES NFA/NFR Letter: 05/26/1998	875 WEST HURON ST.	SSW 1/4 - 1/2 (0.422 mi.)	AD120	214
850 NORTH OGDEN AVE. LLC NFA/NFR Letter: 03/16/2001	850 NORTH OGDEN AVE.	SW 1/4 - 1/2 (0.423 mi.)	AC121	215
BPRS CHESTNUT VENTURE	***361 WEST CHESTNUT***	***ESE 1/4 - 1/2 (0.431 mi.)***	***AF125***	***221***
OFF TRACK BETTING	911 WEED ST., 901-911 W	NNW 1/4 - 1/2 (0.435 mi.)	AB126	222
SPECIAL SERVICE CO NFA/NFR Letter: 06/10/1998	***681 N GREEN ST***	***SSW 1/4 - 1/2 (0.435 mi.)***	***AG127***	***222***
RUTTENBERG, BARNETT NFA/NFR Letter: 02/21/2002	863 NORTH ORLEANS	ESE 1/4 - 1/2 (0.435 mi.)	AF128	224
IZUI PHOTOGRAPHY NFA/NFR Letter: 09/29/1992	315 WEST WALTON	ESE 1/4 - 1/2 (0.435 mi.)	129	225
AMOCO OIL CO. #5093 NFA/NFR Letter: 01/29/1998	1560 NORTH HALSTED	N 1/4 - 1/2 (0.456 mi.)	AH131	227
HALSTED/CLYBOURN/NORTH LLC NFA/NFR Letter: 02/10/2009	1560 NORTH HALSTED STRE	N 1/4 - 1/2 (0.458 mi.)	AH134	230
YELLOW CAB CO.	1004 NORTH ELSTON	SW 1/4 - 1/2 (0.460 mi.)	AK136	233
JOINT MGT. CO., INC. NFA/NFR Letter: 02/02/2000	942-60 WEST HURON	SSW 1/4 - 1/2 (0.462 mi.)	AL138	234
GROUP WEST, LLC	656 NORTH GREEN ST.	SSW 1/4 - 1/2 (0.474 mi.)	AG140	235
1ST BANK SYSTEM	1030 WEST CHICAGO AVE.	SW 1/4 - 1/2 (0.482 mi.)	AN141	236
CHICAGO PAPERBOARD CORP. NFA/NFR Letter: 10/11/2001	949 NORTH ELSTON	SW 1/4 - 1/2 (0.483 mi.)	AK143	241
TRI EQUITIES LLC	865 WEST NORTH AVE.	N 1/4 - 1/2 (0.497 mi.)	144	241
MCZ DEVELOPMENT INC. NFA/NFR Letter: 05/11/2000	1555 NORTH SHEFFIELD	NNW 1/4 - 1/2 (0.498 mi.)	AM146	242

Lower Elevation	Address	Direction / Distance	Map ID	Page
FEDERAL EXPRESS CORP	***875 W DIVISION***	***W 0 - 1/8 (0.061 mi.)***	***F18***	***25***
HOOKER DIVISION L.L.C. NFA/NFR Letter: 05/30/1995	901 DIVISION ST.	W 0 - 1/8 (0.085 mi.)	F31	43
GREYHOUND LINES INC NFA/NFR Letter: 12/09/1997	***901 N HALSTED***	***SW 0 - 1/8 (0.103 mi.)***	***H37***	***68***
MW-CPAG HOLDINGS, LLC NFA/NFR Letter: 05/25/2005	***946 NORTH CROSBY STREET***	***SSE 1/8 - 1/4 (0.129 mi.)***	***J40***	***77***
CROSBY FREEZER INC. NFA/NFR Letter: 05/03/2005	946 NORTH CROSBY	SSE 1/8 - 1/4 (0.129 mi.)	J41	81
AKZO SALT INC. NFA/NFR Letter: 06/17/1992	932 NORTH BRANCH ST.	SW 1/8 - 1/4 (0.197 mi.)	P68	140

Lower Elevation	Address	Direction / Distance	Map ID	Page
MONTGOMERY WARD	***844 N LARRABEE***	***SSE 1/4 - 1/2 (0.253 mi.)***	***U83***	***167***
NFA/NFR Letter: 06/25/1997				
NFA/NFR Letter: 07/26/1995				
VULCAN MATERIALS	1092 NORTH NORTHBRANCH	WSW 1/4 - 1/2 (0.262 mi.)	V86	175
NFA/NFR Letter: 09/09/1999				
CHAS LEVY CO	***1139 N NORTHBRANCH***	***WSW 1/4 - 1/2 (0.276 mi.)***	***V89***	***176***
NFA/NFR Letter: 09/08/2009				
CHAS. LEVY TRANSPORTATION CO.	1200 NORTH BRANCH ST.	W 1/4 - 1/2 (0.365 mi.)	109	207
NFA/NFR Letter: 07/14/2000				
NATIONAL BY PROD.	1371 NORTH NORTH BRANCH	WNW 1/4 - 1/2 (0.417 mi.)	117	212
NFA/NFR Letter: 04/26/1993				
TWO RIVER ROAD LLC	720 NORTH LARABEE STREE	SSE 1/4 - 1/2 (0.418 mi.)	118	213
NFA/NFR Letter: 02/24/2003				
KLEMP CORP	***1132 BLACKHAWK***	***NW 1/4 - 1/2 (0.424 mi.)***	***AE122***	***215***
NFA/NFR Letter: 08/28/1991				
PEPPER CONSTRUCTION	407 WEST CHICAGO	SE 1/4 - 1/2 (0.458 mi.)	AJ133	229
PEPPER CONSTRUCTION	***405 W CHICAGO AVE***	***SE 1/4 - 1/2 (0.459 mi.)***	***AJ135***	***231***
CHICAGO TRIBUNE	700 WEST ERIE STREET	S 1/4 - 1/2 (0.497 mi.)	AI145	242
NFA/NFR Letter: 07/22/2008				

State and tribal registered storage tank lists

UST: The Underground Storage Tank database contains registered USTs. USTs are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA). The data come from the Illinois State Fire Marshal's STC Facility List.

A review of the UST list, as provided by EDR, and dated 02/03/2011 has revealed that there are 24 UST sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
SONOC ARCHITECTS	735 WEST DIVISION STREE	N 0 - 1/8 (0.001 mi.)	C11	16
MOBIL GAS & MINI MART	1234 N. HALSTED	N 0 - 1/8 (0.043 mi.)	B15	20
FORMER SPANJER BROTHERS SITE	645 W ELM ST	ENE 0 - 1/8 (0.046 mi.)	D16	22
VACANT LOT	1116 N HOWE ST	ENE 0 - 1/8 (0.064 mi.)	D22	34
SPANJER BROTHERS INC	1155 N HOWE ST	ENE 0 - 1/8 (0.080 mi.)	D24	36
FORMER SPANJER BROTHERS SITE	1160 N HOWE	ENE 0 - 1/8 (0.081 mi.)	D26	37
FEDERAL EXPRESS STATION	1111 N HOOKER STREET	SW 0 - 1/8 (0.081 mi.)	29	41
VACANT LOT	1116 NORTH HOWE	ENE 0 - 1/8 (0.087 mi.)	G32	44
RIVER WORKS	926 N NORTH BRANCH ST	SW 1/8 - 1/4 (0.140 mi.)	H46	85
VON SCHILLER SCHOOL	640 W. SCOTT STREET	NE 1/8 - 1/4 (0.146 mi.)	L49	88
VACANT LOT	1400 N. DAYTON STREET	N 1/8 - 1/4 (0.185 mi.)	M62	129
JENNER SCHOOL	1009 N CLEVELAND ST	ESE 1/8 - 1/4 (0.189 mi.)	N64	131
WHITE WAY SIGN & MAINT CO	1409 N LARRABEE STREET	NE 1/8 - 1/4 (0.249 mi.)	T82	166

Lower Elevation	Address	Direction / Distance	Map ID	Page
FEDERAL EXPRESS CORP	875 W DIVISION GOOSE IS	W 0 - 1/8 (0.061 mi.)	F21	31
HOOKER/DAVISION LLC	901 W DIVISION ST	W 0 - 1/8 (0.088 mi.)	F33	44
GREYHOUND LINES, INC.	901 N. HALSTED STREET	SW 0 - 1/8 (0.103 mi.)	H38	71
OLD MONTGOMERY WARDS WAREHOUSE	946 N CROSBY AVE	SSE 1/8 - 1/4 (0.129 mi.)	J42	81

Lower Elevation	Address	Direction / Distance	Map ID	Page
BIRCK PATRICIA A. & ISSELHARD	930 W. DIVISION	W 1/8 - 1/4 (0.156 mi.)	I53	99
AKZO SALT INC	932 N BRANCH ST	SW 1/8 - 1/4 (0.197 mi.)	P69	140
FORMER VULACN MATERIALS-GOOSE	1052 N BRANCH ST	SW 1/8 - 1/4 (0.209 mi.)	Q70	141
EPORT C/O AMERIMAR EPORT MGT	***600 W CHICAGO***	***SSE 1/8 - 1/4 (0.209 mi.)***	***O71***	***142***
COMED / VACANT BUILDING	1050 N NORTH BRANCH	SW 1/8 - 1/4 (0.211 mi.)	Q73	145
R A INDUSTRIES INC	1092 N N BRANCH ST	SW 1/8 - 1/4 (0.237 mi.)	Q75	147
NAZDAR CO	1087 N N BRANCH	SW 1/8 - 1/4 (0.247 mi.)	S80	162

State and tribal institutional control / engineering control registries

ENG CONTROLS: Sites with Engineering Controls.

A review of the ENG CONTROLS list, as provided by EDR, and dated 03/04/2011 has revealed that there are 15 ENG CONTROLS sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
OLD TOWN VILLAGE WEST	***1198 NORTH HOWE STREET***	***ENE 0 - 1/8 (0.095 mi.)***	***G35***	***56***
VILLAGE NORTH-CABRINI GREEN EX	***1199 NORTH LARRABEE STR***	***ENE 1/8 - 1/4 (0.152 mi.)***	***52***	***91***
NORTH TOWN VILLAGE	***1401 NORTH HALSTED STRE***	***N 1/8 - 1/4 (0.189 mi.)***	***M65***	***132***
NORTH TOWN VILLAGE	***1421 NORTH HALSTED STRE***	***N 1/8 - 1/4 (0.230 mi.)***	***74***	***145***
NEAR NORTH SRO	***526-538 WEST SCOTT STRE***	***ENE 1/8 - 1/4 (0.245 mi.)***	***77***	***148***
PAL GROUP	***901 NORTH SANGAMON STRE***	***SW 1/4 - 1/2 (0.327 mi.)***	***X95***	***185***
TRUE VALUE MANUFACTURING COMPA	***823 WEST BLACKHAWK AVEN***	***N 1/4 - 1/2 (0.335 mi.)***	***Z101***	***193***
BOATYARD LLC	***1500 NORTH KINGSBURY ST***	***NNW 1/4 - 1/2 (0.338 mi.)***	***Y104***	***201***
923 WEED	***923 WEST WEED STREET***	***NNW 1/4 - 1/2 (0.439 mi.)***	***AB130***	***225***
WATER SAVER FAUCET COMPANY	***660-680 NORTH HALSTED S***	***S 1/4 - 1/2 (0.458 mi.)***	***AI132***	***228***
FIRST BANK SYSTEM	***1030 WEST CHICAGO AVENU***	***SW 1/4 - 1/2 (0.482 mi.)***	***AN142***	***236***

Lower Elevation	Address	Direction / Distance	Map ID	Page
MW-CPAG HOLDINGS, LLC	***946 NORTH CROSBY STREET***	***SSE 1/8 - 1/4 (0.129 mi.)***	***J40***	***77***
SARA LEE BRANDED FOODS	***900 NORTH NORTH BRANCH***	***SW 1/8 - 1/4 (0.132 mi.)***	***H44***	***83***
CMC HEARTLAND PARTNERS	***1220 NORTH HICKORY AVEN***	***W 1/8 - 1/4 (0.176 mi.)***	***58***	***124***
KLEMP CORPORATION	***1132 WEST BLACKHAWK STR***	***NW 1/4 - 1/2 (0.424 mi.)***	***AE123***	***217***

INST CONTROL: Legal or administrative restrictions on land use and/or other activities (e.g., groundwater use restrictions) which effectively limit exposure to contamination may be employed as alternatives to removal or treatment of contamination.

A review of the INST CONTROL list, as provided by EDR, and dated 03/04/2011 has revealed that there are 14 INST CONTROL sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
OLD TOWN VILLAGE WEST	***1198 NORTH HOWE STREET***	***ENE 0 - 1/8 (0.095 mi.)***	***G35***	***56***
VILLAGE NORTH-CABRINI GREEN EX	***1199 NORTH LARRABEE STR***	***ENE 1/8 - 1/4 (0.152 mi.)***	***52***	***91***
NORTH TOWN VILLAGE	***1401 NORTH HALSTED STRE***	***N 1/8 - 1/4 (0.189 mi.)***	***M65***	***132***
NORTH TOWN VILLAGE	***1421 NORTH HALSTED STRE***	***N 1/8 - 1/4 (0.230 mi.)***	***74***	***145***
NEAR NORTH SRO	***526-538 WEST SCOTT STRE***	***ENE 1/8 - 1/4 (0.245 mi.)***	***77***	***148***
PAL GROUP	***901 NORTH SANGAMON STRE***	***SW 1/4 - 1/2 (0.327 mi.)***	***X95***	***185***
TRUE VALUE MANUFACTURING COMPA	***823 WEST BLACKHAWK AVEN***	***N 1/4 - 1/2 (0.335 mi.)***	***Z101***	***193***
WAK PICTURES	***1504 NORTH FREMONT STRE***	***NNW 1/4 - 1/2 (0.406 mi.)***	***AB113***	***209***

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
923 WEED	***923 WEST WEED STREET***	***NNW 1/4 - 1/2 (0.439 mi.)***	***AB130***	***225***
WATER SAVER FAUCET COMPANY	***660-680 NORTH HALSTED S***	***S 1/4 - 1/2 (0.458 mi.)***	***AI132***	***228***
FIRST BANK SYSTEM	***1030 WEST CHICAGO AVENU***	***SW 1/4 - 1/2 (0.482 mi.)***	***AN142***	***236***

Lower Elevation	Address	Direction / Distance	Map ID	Page
MW-CPAG HOLDINGS, LLC	***946 NORTH CROSBY STREET***	***SSE 1/8 - 1/4 (0.129 mi.)***	***J40***	***77***
SARA LEE BRANDED FOODS	***900 NORTH NORTH BRANCH***	***SW 1/8 - 1/4 (0.132 mi.)***	***H44***	***83***
KLEMP CORPORATION	***1132 WEST BLACKHAWK STR***	***NW 1/4 - 1/2 (0.424 mi.)***	***AE123***	***217***

State and tribal voluntary cleanup sites

SRP: Illinois Environmental Protection Agency, Site Remediation Program Database

A review of the SRP list, as provided by EDR, and dated 03/04/2011 has revealed that there are 26 SRP sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
PEOPLES GAS AND LIGHT	NW CORNER CROSBY STREET	0 - 1/8 (0.000 mi.)	6	10
OLD TOWN VILLAGE WEST	***1198 NORTH HOWE STREET***	***ENE 0 - 1/8 (0.095 mi.)***	***G35***	***56***
VILLAGE NORTH-CABRINI GREEN EX	***1199 NORTH LARRABEE STR***	***ENE 1/8 - 1/4 (0.152 mi.)***	***52***	***91***
NORTH TOWN VILLAGE	***1401 NORTH HALSTED STRE***	***N 1/8 - 1/4 (0.189 mi.)***	***M65***	***132***
NORTH TOWN VILLAGE	***1421 NORTH HALSTED STRE***	***N 1/8 - 1/4 (0.230 mi.)***	***74***	***145***
NEAR NORTH SRO	***526-538 WEST SCOTT STRE***	***ENE 1/8 - 1/4 (0.245 mi.)***	***77***	***148***
CLYBOURN LARRABEE LLC	1418 NORTH LARRABEE AVE	NE 1/4 - 1/2 (0.294 mi.)	92	179
PRAIRIE MATERIAL SLS YARD 32	835 NORTH PEORIA STREET	SW 1/4 - 1/2 (0.296 mi.)	93	180
PAL GROUP	***901 NORTH SANGAMON STRE***	***SW 1/4 - 1/2 (0.327 mi.)***	***X95***	***185***
TRUE VALUE MANUFACTURING COMPA	***823 WEST BLACKHAWK AVEN***	***N 1/4 - 1/2 (0.335 mi.)***	***Z101***	***193***
BOATYARD LLC	***1500 NORTH KINGSBURY ST***	***NNW 1/4 - 1/2 (0.338 mi.)***	***Y104***	***201***
RICHARD E. BYRD PUBLIC SCHOOL	363 WEST HILL STREET	E 1/4 - 1/2 (0.346 mi.)	105	202
WAK PICTURES	***1504 NORTH FREMONT STRE***	***NNW 1/4 - 1/2 (0.406 mi.)***	***AB113***	***209***
AAA BOATYARDS	1111 NORTH ELSTON AVENU	WSW 1/4 - 1/2 (0.420 mi.)	119	213
923 WEED	***923 WEST WEED STREET***	***NNW 1/4 - 1/2 (0.439 mi.)***	***AB130***	***225***
WATER SAVER FAUCET COMPANY	***660-680 NORTH HALSTED S***	***S 1/4 - 1/2 (0.458 mi.)***	***AI132***	***228***
MIDWEST ZINC	1001 WEST WEED STREET	NNW 1/4 - 1/2 (0.464 mi.)	AM139	234
FIRST BANK SYSTEM	***1030 WEST CHICAGO AVENU***	***SW 1/4 - 1/2 (0.482 mi.)***	***AN142***	***236***

Lower Elevation	Address	Direction / Distance	Map ID	Page
PEOPLES GAS LASALLE CHESTNUT P	1040 NORTH KINGSBURY ST	SSE 0 - 1/8 (0.053 mi.)	E17	24
FEDERAL EXPRESS CORPORATION	875 WEST DIVISION STREE	W 0 - 1/8 (0.061 mi.)	F19	30
MW-CPAG HOLDINGS, LLC	***946 NORTH CROSBY STREET***	***SSE 1/8 - 1/4 (0.129 mi.)***	***J40***	***77***
SARA LEE BRANDED FOODS	***900 NORTH NORTH BRANCH***	***SW 1/8 - 1/4 (0.132 mi.)***	***H44***	***83***
CMC HEARTLAND PARTNERS	***1220 NORTH HICKORY AVEN***	***W 1/8 - 1/4 (0.176 mi.)***	***58***	***124***
EPORT	600 WEST CHICAGO AVENUE	SSE 1/8 - 1/4 (0.209 mi.)	O72	144
CLEVELAND TOWERS	460-472 WEST CHICAGO AV	SE 1/4 - 1/2 (0.413 mi.)	115	211
KLEMP CORPORATION	***1132 WEST BLACKHAWK STR***	***NW 1/4 - 1/2 (0.424 mi.)***	***AE123***	***217***

EXECUTIVE SUMMARY

ADDITIONAL ENVIRONMENTAL RECORDS

Other Ascertainable Records

RCRA-NonGen: RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Non-Generators do not presently generate hazardous waste.

A review of the RCRA-NonGen list, as provided by EDR, and dated 03/11/2011 has revealed that there are 9 RCRA-NonGen sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
COOK COUNTY DISPOSAL CO	***800 W DIVISION ST***	***0 - 1/8 (0.000 mi.)***	***B9***	***11***
SPANJER BROS INC	***1160 N HOWE ST***	***ENE 0 - 1/8 (0.081 mi.)***	***D28***	***39***
SARA LEE BRANDED FOODS	***900 N BRANCH ST***	***SW 1/8 - 1/4 (0.144 mi.)***	***K47***	***85***
OUTER CIRCLE PRODUCTS	***860 W EVERGREEN AVE***	***NNW 1/8 - 1/4 (0.161 mi.)***	***55***	***120***
WRIGHTWOOD ENTERPRISES INC	***818 W EVERGREEN***	***N 1/8 - 1/4 (0.184 mi.)***	***M60***	***127***
CAR CARE /DBA/ C W AUTOBODY	***1433 N DAYTON***	***N 1/8 - 1/4 (0.246 mi.)***	***R78***	***150***

Lower Elevation	Address	Direction / Distance	Map ID	Page
PRECISION ENERGY SYSTEMS INC	***930 DIVISION ST***	***W 1/8 - 1/4 (0.156 mi.)***	***I54***	***100***
NORTHEASTERN ILLINOIS UNIVERSI	770 N HALSTED ST 4TH FL	SSW 1/8 - 1/4 (0.174 mi.)	57	123
EPORT C/O AMERIMAR EPORT MGT	***600 W CHICAGO***	***SSE 1/8 - 1/4 (0.209 mi.)***	***O71***	***142***

MINES: Mines Master Index File. The source of this database is the Dept. of Labor, Mine Safety and Health Administration.

A review of the MINES list, as provided by EDR, and dated 02/08/2011 has revealed that there is 1 MINES site within approximately 0.25 miles of the target property.

Lower Elevation	Address	Direction / Distance	Map ID	Page
INTNL SALT		SW 1/8 - 1/4 (0.245 mi.)	76	148

EDR PROPRIETARY RECORDS

EDR Proprietary Records

Manufactured Gas Plants: The EDR Proprietary Manufactured Gas Plant Database includes records of coal gas plants (manufactured gas plants) compiled by EDR's researchers. Manufactured gas sites were used in the United States from the 1800's to 1950's to produce a gas that could be distributed and used as fuel. These plants used whale oil, rosin, coal, or a mixture of coal, oil, and water that also produced a significant amount of waste. Many of the byproducts of the gas production, such as coal tar (oily waste containing volatile and non-volatile chemicals), sludges, oils and other compounds are potentially hazardous to human health and the environment. The byproduct from this process was frequently disposed of directly at the plant site and can remain or spread slowly, serving as a continuous source of soil and groundwater contamination.

A review of the Manufactured Gas Plants list, as provided by EDR, has revealed that there are 5

Manufactured Gas Plants sites within approximately 1 mile of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
PEOPLES GAS AND LIGHT	1241 WEST DIVISION STRE	WSW 1/2 - 1 (0.530 mi.)	148	243
PEOPLES GAS AND LIGHT	1780 NORTH MARCEY STREE	NNW 1/2 - 1 (0.798 mi.)	149	243
PEOPLES GAS AND LIGHT	1818-1854 NORTH MARCEY	NNW 1/2 - 1 (0.852 mi.)	150	243

Lower Elevation	Address	Direction / Distance	Map ID	Page
PEOPLES GAS AND LIGHT	NW CORNER CROSBY AND HO	SSE 0 - 1/8 (0.061 mi.)	E20	31
PEOPLES GAS AND LIGHT	409-431 WEST SUPERIOR S	SE 1/2 - 1 (0.502 mi.)	147	243

EDR Historical Auto Stations: EDR has searched selected national collections of business directories and has collected listings of potential gas station/filling station/service station sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include gas station/filling station/service station establishments. The categories reviewed included, but were not limited to gas, gas station, gasoline station, filling station, auto, automobile repair, auto service station, service station, etc.

A review of the EDR Historical Auto Stations list, as provided by EDR, has revealed that there are 2 EDR Historical Auto Stations sites within approximately 0.25 miles of the target property.

Lower Elevation	Address	Direction / Distance	Map ID	Page
YELLOW BLACK SERVICE STA	1135 N HALSTED	0 - 1/8 (0.000 mi.)	7	11
VAN DER HEYDEN BROS	942 CROSBY	SSE 1/8 - 1/4 (0.132 mi.)	J43	82

EDR Historical Cleaners: EDR has searched selected national collections of business directories and has collected listings of potential dry cleaner sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include dry cleaning establishments. The categories reviewed included, but were not limited to dry cleaners, cleaners, laundry, laundromat, cleaning/laundry, wash & dry etc.

A review of the EDR Historical Cleaners list, as provided by EDR, has revealed that there are 2 EDR Historical Cleaners sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
OGDEN AV LAUNDRY	1217 BURLING	N 0 - 1/8 (0.096 mi.)	36	68
BROMBERG FUR DRESSING DYEING	1402 N HALSTED	N 1/8 - 1/4 (0.191 mi.)	M66	138

EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped. Count: 20 records.

Site Name	Database(s)
CORNERSTONE CLEANERS	RCRA-SQG
CHICAGO DEPT OF TRANS VIADUCT	RCRA-LQG
COMED MANHOLE	RCRA-NLR
COOK COUNTY HWY DEPT	FINDS,RCRA-CESQG
USEDA NORTH CENTRAL LABORATORIES	FINDS,RCRA-CESQG
TEAMSTERS LOCAL 734 BLOCK 22	FINDS,RCRA-CESQG
MARINA CITY MARINA	FINDS,RCRA-CESQG
CHICAGO DOT TRANSIT	FINDS,RCRA-CESQG
NORTH CHICAGO RIVER CONTROL WORKS	FINDS,RCRA-CESQG
BERWIN STATION	ERNS
2300 BLOCK OF NORTH AVE	ERNS
NEAR ADDISON STATION	ERNS
700 NORTH POLASKI	ERNS
CENTRAL STATION DEV	FINDS
NORTH BRANCH CHICAGO RIVER	FINDS
PEOPLES GAS: NORTH STATION	FINDS
NORTH SHORE TOWING RELO	FINDS
NORTH CHICAGO RIVER CONTROL WK	FINDS
ROSELAND COMMUNITY	BROWNFIELDS
PEOPLES GAS LIGHT & COKE NORTH STA	ICIS

OVERVIEW MAP - 3066595.2s

- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- National Priority List Sites
- Dept. Defense Sites
- Indian Reservations BIA
- County Boundary
- Power transmission lines
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- National Wetland Inventory

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME:	North Station	CLIENT:	Natural Resource Technology
ADDRESS:	1127 Halsted	CONTACT:	Robert Karnauskas
	Chicago IL 60610	INQUIRY #:	3066595.2s
LAT/LONG:	41.9021 / 87.6460	DATE:	May 12, 2011 4:37 pm

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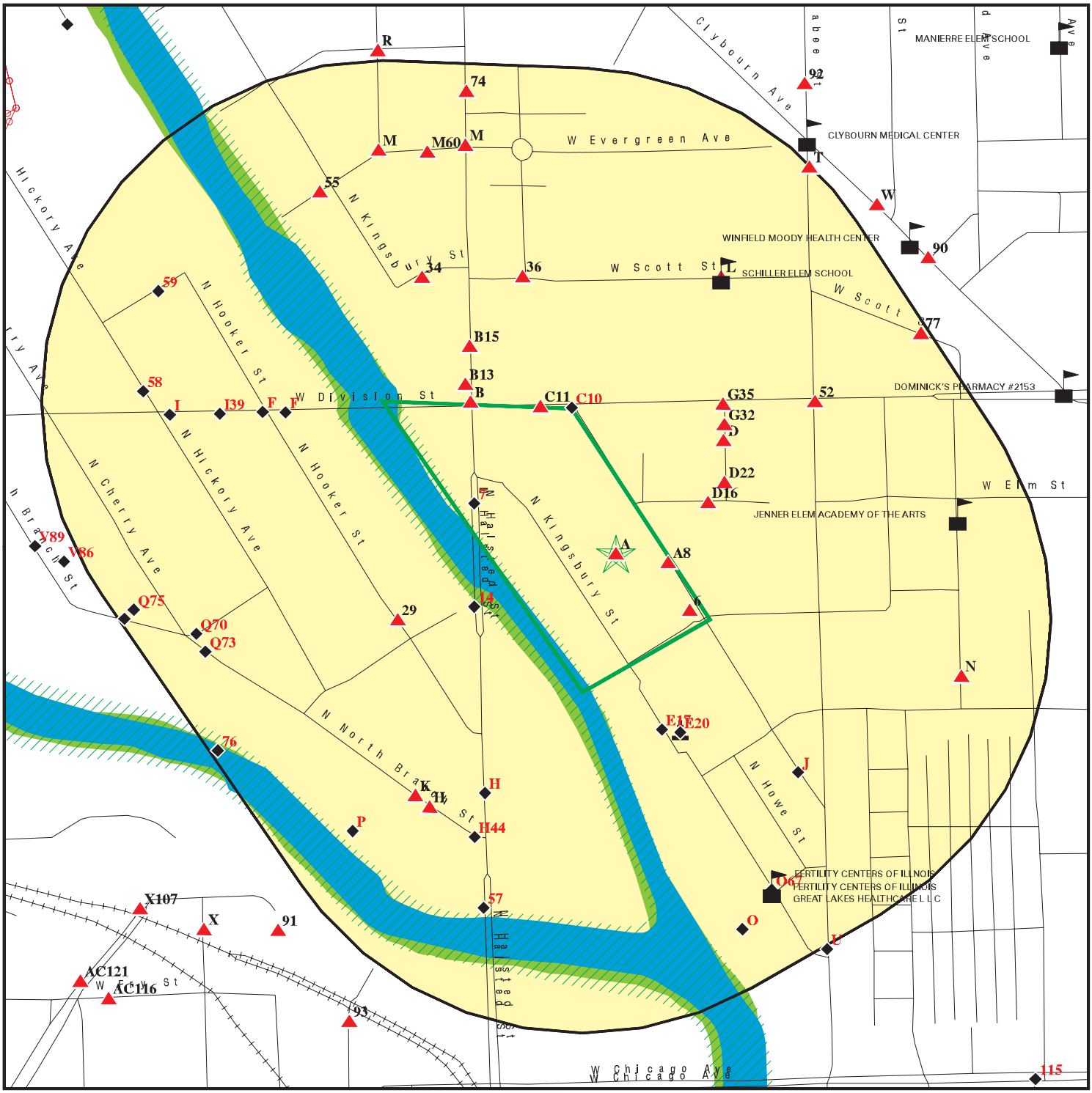
DETAIL MAP - 3066595.2s



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- Sensitive Receptors
- National Priority List Sites
- Dept. Defense Sites
- Indian Reservations BIA
- Power transmission lines
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- National Wetland Inventory

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME: North Station	CLIENT: Natural Resource Technology
ADDRESS: 1127 Halsted	CONTACT: Robert Karnauskas
Chicago IL 60610	INQUIRY #: 3066595.2s
LAT/LONG: 41.9021 / 87.6460	DATE: May 12, 2011 4:38 pm

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MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
STANDARD ENVIRONMENTAL RECORDS								
Federal NPL site list								
NPL		1.000	0	0	0	0	NR	0
Proposed NPL		1.000	0	0	0	0	NR	0
NPL LIENS		TP	NR	NR	NR	NR	NR	0
Federal Delisted NPL site list								
Delisted NPL		1.000	0	0	0	0	NR	0
Federal CERCLIS list								
CERCLIS		0.500	1	0	0	NR	NR	1
FEDERAL FACILITY		1.000	0	0	0	0	NR	0
Federal CERCLIS NFRAP site List								
CERC-NFRAP		0.500	1	0	4	NR	NR	5
Federal RCRA CORRACTS facilities list								
CORRACTS		1.000	0	0	2	1	NR	3
Federal RCRA non-CORRACTS TSD facilities list								
RCRA-TSDF		0.500	0	0	0	NR	NR	0
Federal RCRA generators list								
RCRA-LQG		0.250	0	1	NR	NR	NR	1
RCRA-SQG		0.250	6	3	NR	NR	NR	9
RCRA-CESQG		0.250	3	3	NR	NR	NR	6
Federal institutional controls / engineering controls registries								
US ENG CONTROLS		0.500	0	0	0	NR	NR	0
US INST CONTROL		0.500	0	0	0	NR	NR	0
Federal ERNS list								
ERNS		TP	NR	NR	NR	NR	NR	0
State- and tribal - equivalent CERCLIS								
SSU		1.000	0	0	0	0	NR	0
State and tribal landfill and/or solid waste disposal site lists								
SWF/LF		0.500	0	0	1	NR	NR	1
LF SPECIAL WASTE		0.500	0	0	0	NR	NR	0
IL NIPC		0.500	0	0	0	NR	NR	0
CCDD		0.500	0	0	0	NR	NR	0
State and tribal leaking storage tank lists								
LUST	X	0.500	5	7	44	NR	NR	56
LUST TRUST		0.500	0	0	0	NR	NR	0

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
INDIAN LUST		0.500	0	0	0	NR	NR	0
State and tribal registered storage tank lists								
UST	X	0.250	11	13	NR	NR	NR	24
INDIAN UST		0.250	0	0	NR	NR	NR	0
FEMA UST		0.250	0	0	NR	NR	NR	0
State and tribal institutional control / engineering control registries								
ENG CONTROLS		0.500	1	7	7	NR	NR	15
INST CONTROL		0.500	1	6	7	NR	NR	14
State and tribal voluntary cleanup sites								
SRP		0.500	4	8	14	NR	NR	26
INDIAN VCP		0.500	0	0	0	NR	NR	0
State and tribal Brownfields sites								
BROWNFIELDS		0.500	0	0	0	NR	NR	0
ADDITIONAL ENVIRONMENTAL RECORDS								
Local Brownfield lists								
US BROWNFIELDS		0.500	0	0	0	NR	NR	0
Local Lists of Landfill / Solid Waste Disposal Sites								
ODI		0.500	0	0	0	NR	NR	0
DEBRIS REGION 9		0.500	0	0	0	NR	NR	0
INDIAN ODI		0.500	0	0	0	NR	NR	0
Local Lists of Hazardous waste / Contaminated Sites								
US CDL		TP	NR	NR	NR	NR	NR	0
CDL		TP	NR	NR	NR	NR	NR	0
US HIST CDL		TP	NR	NR	NR	NR	NR	0
Local Land Records								
LIENS 2		TP	NR	NR	NR	NR	NR	0
LUCIS		0.500	0	0	0	NR	NR	0
Records of Emergency Release Reports								
HMIRS		TP	NR	NR	NR	NR	NR	0
SPILLS		TP	NR	NR	NR	NR	NR	0
Other Ascertainable Records								
RCRA-NonGen		0.250	2	7	NR	NR	NR	9
DOT OPS		TP	NR	NR	NR	NR	NR	0
DOD		1.000	0	0	0	0	NR	0
FUDS		1.000	0	0	0	0	NR	0
CONSENT		1.000	0	0	0	0	NR	0

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
ROD		1.000	0	0	0	0	NR	0
UMTRA		0.500	0	0	0	NR	NR	0
MINES		0.250	0	1	NR	NR	NR	1
TRIS		TP	NR	NR	NR	NR	NR	0
TSCA		TP	NR	NR	NR	NR	NR	0
FTTS		TP	NR	NR	NR	NR	NR	0
HIST FTTS		TP	NR	NR	NR	NR	NR	0
SSTS		TP	NR	NR	NR	NR	NR	0
ICIS		TP	NR	NR	NR	NR	NR	0
PADS		TP	NR	NR	NR	NR	NR	0
MLTS		TP	NR	NR	NR	NR	NR	0
RADINFO		TP	NR	NR	NR	NR	NR	0
FINDS	X	TP	NR	NR	NR	NR	NR	0
RAATS		TP	NR	NR	NR	NR	NR	0
UIC		TP	NR	NR	NR	NR	NR	0
NPDES		TP	NR	NR	NR	NR	NR	0
DRYCLEANERS		0.250	0	0	NR	NR	NR	0
IMPDMENT		0.500	0	0	0	NR	NR	0
AIRS	X	TP	NR	NR	NR	NR	NR	0
TIER 2		TP	NR	NR	NR	NR	NR	0
INDIAN RESERV		1.000	0	0	0	0	NR	0
SCRD DRYCLEANERS		0.500	0	0	0	NR	NR	0
PCB TRANSFORMER		TP	NR	NR	NR	NR	NR	0
COAL ASH EPA		0.500	0	0	0	NR	NR	0
COAL ASH DOE		TP	NR	NR	NR	NR	NR	0
PIMW		0.250	0	0	NR	NR	NR	0
FINANCIAL ASSURANCE		TP	NR	NR	NR	NR	NR	0
EDR PROPRIETARY RECORDS								
EDR Proprietary Records								
Manufactured Gas Plants		1.000	1	0	0	4	NR	5
EDR Historical Auto Stations		0.250	1	1	NR	NR	NR	2
EDR Historical Cleaners		0.250	1	1	NR	NR	NR	2

NOTES:

TP = Target Property

NR = Not Requested at this Search Distance

Sites may be listed in more than one database

A1 **DIVISION-HALSTED LLC** **FINDS** **1004479823**
Target **1111-1127 N HALSTED ST** **N/A**
Property **CHICAGO, IL 60622**

Site 1 of 6 in cluster A

Actual: **585 ft.**

FINDS:

Registry ID: 110001286778

Environmental Interest/Information System
ACES (Illinois - Agency Compliance And Enforcement System) is the Illinois EPA Project to facilitate the permitting operations

---

A2 **OLD RICH HEIMER COFFEE CO.** **UST** **U003987988**
Target **1111-1127 NORTH HALSTED** **N/A**
Property **CHICAGO, IL 60622**

Site 2 of 6 in cluster A

Actual: **585 ft.**

UST:

Facility ID:	2042662
Facility Status:	Exempt
Facility Type:	**None**
Owner Name:	Division - Halsted, LLC
Owner Id:	U0032520
Owner Address:	3924 W. Devon Avenue, Suite 202
Owner City,St,Zip:	Lincolnwood, IL 60712
Tank Number:	1
Tank Capacity:	15000
Tank Substance:	Gasoline
Last Used Date:	12/31/1973
OSFM First Notify Date:	Not reported
Tank Status:	**Exempt from registration**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported
Tank Number:	2
Tank Capacity:	15000
Tank Substance:	Gasoline
Last Used Date:	12/31/1973
OSFM First Notify Date:	Not reported
Tank Status:	**Exempt from registration**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

OLD RICH HEIMER COFFEE CO. (Continued) **U003987988**

Tank Number:	3
Tank Capacity:	15000
Tank Substance:	Gasoline
Last Used Date:	12/31/1973
OSFM First Notify Date:	Not reported
Tank Status:	**Exempt from registration**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	4
Tank Capacity:	6000
Tank Substance:	Heating Oil
Last Used Date:	12/31/1973
OSFM First Notify Date:	Not reported
Tank Status:	**Exempt from registration**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	5
Tank Capacity:	0
Tank Substance:	None
Last Used Date:	Not reported
OSFM First Notify Date:	Not reported
Tank Status:	**Does Not Exist**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

A3 **DIVISION-HALSTED LLC** **LUST** **S106781230**
Target **1111-27 NORTH HALSTED STREET** **N/A**
Property **CHICAGO, IL 60622**

Site 3 of 6 in cluster A

Actual:
585 ft.

LUST:

Incident Num:	20041769
IL EPA Id:	0316246341
Product:	Gasoline, Other Petro
IEMA Date:	12/19/2004

DIVISION-HALSTED LLC (Continued) **S106781230**

Project Manager:	Putrich
Project Manager Phone:	(217) 524-4827
Email:	Steve.Putrich@illinois.gov
PRP Name:	Not reported
PRP Contact:	Not reported
PRP Address:	Not reported
PRP City,St,Zip:	Not reported
PRP Phone:	Not reported
Site Classification:	Not reported
Section 57.5(g) Letter:	P.A.
Non LUST Determination Letter:	Not reported
20 Report Received:	02/02/2005
45 Report Received:	03/09/2005
Section 57.5(g) Letter:	Not reported
NFA/NFR Letter:	**06/24/2005**
NFR Date Recorded:	08/18/2005

A4 **DIVISION-HALSTED LLC** **AIRS** **S107741455**
Target **1111-1127 N HALSTED ST** **N/A**
Property **CHICAGO, IL**

Site 4 of 6 in cluster A

Actual:
585 ft.

IL AIRS:

Facility ID:	3950
ID Number:	031600FKH
Year:	Not reported
Contact Name:	Not reported
Contact Title:	Not reported
Contact Tele:	Not reported
Contact Extention:	Not reported
Contact EMail:	Not reported
Contact Fax:	Not reported
Cease Operation Date:	3/17/1999
SIC Code:	2095
Address Type Code:	LOC

A5 **RICHHEIMER COFFEE COMPANY** **FINDS** **1012091534**
Target **1127 NORTH HALSTED STREET** **N/A**
Property **CHICAGO, IL 60622**

Site 5 of 6 in cluster A

Actual:
585 ft.

FINDS:

Registry ID: 110038742046

Environmental Interest/Information System

AFS (Aerometric Information Retrieval System (AIRS) Facility Subsystem) replaces the former Compliance Data System (CDS), the National Emission Data System (NEDS), and the Storage and Retrieval of Aerometric Data (SAROAD). AIRS is the national repository for information concerning airborne pollution in the United States. AFS is used to track emissions and compliance data from industrial plants. AFS data are utilized by states to prepare State Implementation Plans to comply with regulatory programs and by EPA as an input for the

RICHHEIMER COFFEE COMPANY (Continued) **1012091534**

estimation of total national emissions. AFS is undergoing a major redesign to support facility operating permits required under Title V of the Clean Air Act.

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6 **PEOPLES GAS AND LIGHT** **SRP** **S104491544**
NW CORNER CROSBY STREET & HOBBIE STR **N/A**
< 1/8 **CHICAGO, IL 60610**
1 ft.

Relative: Higher

Actual: 585 ft.

SRP:

IL EPA Id:	0316080031
US EPA Id:	ILD982074775
Longitude:	-87.646159999999995
Latitude:	41.901420000000002
Contact Name:	Steven Matuszak
Contact Address:	130 East Randolph Drive
Contact Address2:	Not reported
Contact City,St,Zip:	Chicago, IL 60601-
Contact Phone:	(312) 240-4560
Date Enrolled:	01/13/1993
Point Of Contact:	Not reported
Consultant Company:	Not reported
Consultant Address:	Not reported
Consultant Address2:	Not reported
Consultant City,St,Zip:	Not reported
Consultant Phone:	Not reported
Proj Mgr Assigned:	Seul
Sec. 4 Letter Date:	Not reported
NFR Recorded:	Not reported
Active:	False
Total Acres:	Not reported
No Further Remediation Letter Dt:	Not reported
Remediation Applicant Co:	The Peoples Gas Light and Coke Company
Remediation Applicant Title:	Mr.
Remediation Applicant Name:	Not reported
Remediation Applicant Company:	Not reported
Remediation Applicant Address:	Not reported
Remediation Applicant Address 2:	Not reported
Remediation Applicant City,St,Zip:	Not reported
Illinois EPA:	Not reported
Site Name:	Not reported
NFR Letter:	Not reported
NFR Letter Date Recorded:	Not reported
Site Type:	Not reported
Comprehensive/Focused:	Not reported
Institutional Controls:	Not reported
Barrier:	Not reported
Worker Caution:	Not reported
Acres:	Not reported

7 **YELLOW BLACK SERVICE STA** **EDR Historical Auto Stations** **1009097989**
1135 N HALSTED **N/A**
< 1/8 **CHICAGO, IL**
1 ft.

Relative: **Lower**

Actual: **581 ft.**

EDR Historical Auto Stations:
Name: YELLOW BLACK SERVICE STA
Year: 1928
Type: GASOLINE AND OIL SERVICE STATIONS

A8 **COMMONWEALTH EDISON NORTH STA** **CERC-NFRAP** **1003870055**
1122 N CROSBY ST **ILD980606321**
< 1/8 **CHICAGO, IL 60611**
1 ft.

Site 6 of 6 in cluster A

Relative: **Higher**

Actual: **585 ft.**

CERC-NFRAP:
Site ID: 0500608
Federal Facility: Not a Federal Facility
NPL Status: Not on the NPL
Non NPL Status: NFRAP-Site does not qualify for the NPL based on existing information

Program Priority:
Description: Great Lakes

CERCLIS-NFRAP Assessment History:
Action: DISCOVERY
Date Started: Not reported
Date Completed: 06/01/1981
Priority Level: Not reported

Action: PRELIMINARY ASSESSMENT
Date Started: Not reported
Date Completed: 06/01/1983
Priority Level: Low priority for further assessment

Action: PRELIMINARY ASSESSMENT
Date Started: Not reported
Date Completed: 03/27/1990
Priority Level: NFRAP-Site does not qualify for the NPL based on existing information

Action: ARCHIVE SITE
Date Started: Not reported
Date Completed: 03/27/1990
Priority Level: Not reported

B9 **COOK COUNTY DISPOSAL CO** **RCRA-NonGen** **1000266270**
800 W DIVISION ST **FINDS** **ILD066185901**
< 1/8 **CHICAGO, IL 60622**
1 ft.

Site 1 of 4 in cluster B

Relative: **Higher**

Actual: **586 ft.**

RCRA-NonGen:
Date form received by agency: 08/13/2009
Facility name: COOK COUNTY DISPOSAL CO
Facility address: 800 W DIVISION ST
CHICAGO, IL 60622

COOK COUNTY DISPOSAL CO (Continued) **1000266270**

EPA ID: ILD066185901
Contact: ROBERT WILKE
Contact address: 800 W DIVISION ST
CHICAGO, IL 60622
Contact country: US
Contact telephone: (312) 642-4312
Contact email: Not reported
EPA Region: 05
Classification: Non-Generator
Description: Handler: Non-Generators do not presently generate hazardous waste

Owner/Operator Summary:
Owner/operator name: NAME NOT REPORTED
Owner/operator address: ADDRESS NOT REPORTED
CITY NOT REPORTED, AK 99998
Owner/operator country: Not reported
Owner/operator telephone: (312) 555-1212
Legal status: Private
Owner/Operator Type: Operator
Owner/Op start date: Not reported
Owner/Op end date: Not reported

Owner/operator name: COOK COUNTY DISPOSAL CO
Owner/operator address: ADDRESS NOT REPORTED
CITY NOT REPORTED, AK 99998
Owner/operator country: Not reported
Owner/operator telephone: (312) 555-1212
Legal status: Private
Owner/Operator Type: Owner
Owner/Op start date: Not reported
Owner/Op end date: Not reported

Handler Activities Summary:
U.S. importer of hazardous waste: No
Mixed waste (haz. and radioactive): No
Recycler of hazardous waste: No
Transporter of hazardous waste: No
Treater, storer or disposer of HW: No
Underground injection activity: No
On-site burner exemption: No
Furnace exemption: No
Used oil fuel burner: No
Used oil processor: No
User oil refiner: No
Used oil fuel marketer to burner: No
Used oil Specification marketer: No
Used oil transfer facility: No
Used oil transporter: No

Historical Generators:
Date form received by agency: 10/15/1980
Facility name: COOK COUNTY DISPOSAL CO
Classification: Not a generator, verified

Violation Status: No violations found

COOK COUNTY DISPOSAL CO (Continued) **1000266270**

FINDS:

Registry ID: 110009370518

Environmental Interest/Information System
RCRAInfo is a national information system that supports the Resource Conservation and Recovery Act (RCRA) program through the tracking of events and activities related to facilities that generate, transport, and treat, store, or dispose of hazardous waste. RCRAInfo allows RCRA program staff to track the notification, permit, compliance, and corrective action activities required under RCRA.

C10 **PEOPLES GAS LIGHT & COKE NORTH STA** **CERCLIS 1000348143**
N. CROSBY & W. DIVISION & W. HOBBIE ST **FINDS ILD982074775**
< 1/8 **CHICAGO, IL 60610**
0.001 mi.
4 ft. **Site 1 of 2 in cluster C**

Relative:
Lower

Actual:
584 ft.

CERCLIS:

Site ID:	0505488
EPA ID:	ILD982074775
Facility County:	COOK
Short Name:	PEOPLES GAS LIGHT & COKE
Congressional District:	07
IFMS ID:	B5FX
SMSA Number:	1600
USGC Hydro Unit:	07120003
Federal Facility:	Not a Federal Facility
DMNSN Number:	8.00000
Site Orphan Flag:	N
RCRA ID:	Not reported
USGS Quadrangle:	Not reported
Site Init By Prog:	Not reported
NFRAP Flag:	Not reported
Parent ID:	Not reported
RST Code:	Not reported
EPA Region:	05
Classification:	Not reported
Site Settings Code:	Not reported
NPL Status:	Not on the NPL
DMNSN Unit Code:	ACRE
RBRAC Code:	Not reported
RResp Fed Agency Code:	Not reported
Non NPL Status:	Remedial Activities Under EPA Enforcement
Non NPL Status Date:	20081031
Site Fips Code:	17031
CC Concurrence Date:	Not reported
CC Concurrence FY:	Not reported
Alias EPA ID:	Not reported
Site FUDS Flag:	Not reported

CERCLIS Site Contact Name(s):

Contact ID:	5271033.00000
Contact Name:	MIKE JOYCE
Contact Tel:	(312) 353-5546
Contact Title:	Community Involvement Coordinator

PEOPLES GAS LIGHT & COKE NORTH STA (Continued) **1000348143**

Contact Email: Not reported

Contact ID: 5270006.00000
Contact Name: ROSS DEL ROSARIO
Contact Tel: (312) 886-6195
Contact Title: Remedial Project Manager (RPM)
Contact Email: delrosario.rosauro@epa.gov

Contact ID: 13002783.00000
Contact Name: TaNaisha Lee
Contact Tel: (312) 886-7570
Contact Title: Remedial Project Manager (RPM)
Contact Email: lee.tanaisha@epa.gov

Alias Comments: Not reported
Site Description: The Chicago Gas Light and Coke company built this facility in 1868 for production of coal gas. In 1887, production was converted to water gas. The facility was closed in the early 1960s. The primary MGP structures included a 1.5 million cubic foot gas holder, two 500,000 cubic foot relief holders, and a 750,000 gallon oil tank as well as underground oil tanks, tar settling wells, a tar tank, a naphtha tank, tar extractors, oil condensers, pumps and scrubbers, an ash hopper, and various buildings. The parcels adjacent to the North Branch Canal were used for coal storage.

CERCLIS Assessment History:

Action Code: 001
Action: DISCOVERY
Date Started: Not reported
Date Completed: 01/29/1988
Priority Level: Not reported
Operable Unit: SITEWIDE
Primary Responsibility: State, Fund Financed
Planning Status: Not reported
Urgency Indicator: Not reported
Action Anomaly: Not reported

For detailed financial records, contact EDR for a Site Report.:

Action Code: 001
Action: PRELIMINARY ASSESSMENT
Date Started: Not reported
Date Completed: 01/10/1989
Priority Level: Low priority for further assessment
Operable Unit: SITEWIDE
Primary Responsibility: State, Fund Financed
Planning Status: Not reported
Urgency Indicator: Not reported
Action Anomaly: Not reported

For detailed financial records, contact EDR for a Site Report.:

Action Code: 001
Action: ADMINISTRATIVE ORDER ON CONSENT
Date Started: Not reported
Date Completed: 06/05/2007
Priority Level: Multi-Site-Subsequent Site

PEOPLES GAS LIGHT & COKE NORTH STA (Continued) **1000348143**

Operable Unit: SITEWIDE
Primary Responsibility: Federal Enforcement
Planning Status: Not reported
Urgency Indicator: Not reported
Action Anomaly: Not reported

For detailed financial records, contact EDR for a Site Report.:

Action Code: 001
Action: SITE REASSESSMENT
Date Started: 04/11/2007
Date Completed: 03/31/2008
Priority Level: Higher priority for further assessment
Operable Unit: SITEWIDE
Primary Responsibility: State, Fund Financed
Planning Status: Not reported
Urgency Indicator: Not reported
Action Anomaly: Not reported

For detailed financial records, contact EDR for a Site Report.:

Action Code: 002
Action: ADMINISTRATIVE ORDER ON CONSENT
Date Started: Not reported
Date Completed: 10/31/2008
Priority Level: Not reported
Operable Unit: SITEWIDE
Primary Responsibility: Federal Enforcement
Planning Status: Not reported
Urgency Indicator: Not reported
Action Anomaly: Not reported

For detailed financial records, contact EDR for a Site Report.:

Action Code: 001
Action: POTENTIALLY RESPONSIBLE PARTY REMEDIAL INVESTIGATION/FEASIBILITY STUDY
Date Started: 10/31/2008
Date Completed: Not reported
Priority Level: Not reported
Operable Unit: SITEWIDE
Primary Responsibility: Responsible Party
Planning Status: Not reported
Urgency Indicator: Not reported
Action Anomaly: Not reported

For detailed financial records, contact EDR for a Site Report.:

Action Code: 001
Action: ENGINEERING EVALUATION/COST ANALYSIS
Date Started: 06/05/2007
Date Completed: 10/31/2008
Priority Level: Not reported
Operable Unit: SITEWIDE
Primary Responsibility: Responsible Party

PEOPLES GAS LIGHT & COKE NORTH STA (Continued) **1000348143**

Planning Status: Primary
Urgency Indicator: Not reported
Action Anomaly: Other Start and Completion Anomaly

For detailed financial records, contact EDR for a Site Report.:

Click this hyperlink while viewing on your computer to access additional US CERCLIS Financial: detail in the EDR Site Report.

FINDS:

Registry ID: 110009326700

Environmental Interest/Information System
CERCLIS (Comprehensive Environmental Response, Compensation, and Liability Information System) is the Superfund database that is used to support management in all phases of the Superfund program. The system contains information on all aspects of hazardous waste sites, including an inventory of sites, planned and actual site activities, and financial information.

C11 **SONOC ARCHITECTS** **UST** **U003668672**
North **735 WEST DIVISION STREET** **N/A**
< 1/8 **CHICAGO, IL 60610**
0.001 mi.
6 ft. **Site 2 of 2 in cluster C**

Relative:
Higher

Actual:
585 ft.

UST:

Facility ID:	2038810
Facility Status:	Exempt
Facility Type:	**None**
Owner Name:	Sonoc Architects
Owner Id:	U0028628
Owner Address:	735 West Division Street
Owner City,St,Zip:	Chicago, IL 60610
Tank Number:	1
Tank Capacity:	2700
Tank Substance:	Heating Oil
Last Used Date:	12/31/1973
OSFM First Notify Date:	Not reported
Tank Status:	**Exempt from registration**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

B12 **CITY OF CHICAGO/ABANDONED PROPERTY** **RCRA-CESQG** **1004698378**
North **1200 N HALSTED ST** **FINDS** **ILR000106252**
< 1/8 **CHICAGO, IL 60622**
0.002 mi.
12 ft. **Site 2 of 4 in cluster B**

Relative:
Higher

Actual:
586 ft.

RCRA-CESQG:

Date form received by agency:	06/01/2001
Facility name:	CITY OF CHICAGO/ABANDONED PROPERTY
Facility address:	1200 N HALSTED ST CHICAGO, IL 60622
EPA ID:	ILR000106252
Mailing address:	30 N LASALLE 25TH FLR CHICAGO, IL 60601
Contact:	PETE BADILLO
Contact address:	30 N LASALLE 25TH FLR CHICAGO, IL 60601
Contact country:	US
Contact telephone:	(312) 656-6992
Contact email:	Not reported
EPA Region:	05
Classification:	Conditionally Exempt Small Quantity Generator
Description:	Handler: generates 100 kg or less of hazardous waste per calendar month, and accumulates 1000 kg or less of hazardous waste at any time; or generates 1 kg or less of acutely hazardous waste per calendar month, and accumulates at any time: 1 kg or less of acutely hazardous waste; or 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste; or generates 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste during any calendar month, and accumulates at any time: 1 kg or less of acutely hazardous waste; or 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste

Owner/Operator Summary:

Owner/operator name:	CITY OF CHICAGO
Owner/operator address:	30 N LASALLE 25TH FLR CHICAGO, IL 60601
Owner/operator country:	Not reported
Owner/operator telephone:	(312) 656-6992
Legal status:	Private
Owner/Operator Type:	Owner
Owner/Op start date:	01/01/0001
Owner/Op end date:	Not reported

Handler Activities Summary:

U.S. importer of hazardous waste:	No
Mixed waste (haz. and radioactive):	No
Recycler of hazardous waste:	No
Transporter of hazardous waste:	No
Treater, storer or disposer of HW:	No
Underground injection activity:	No
On-site burner exemption:	No
Furnace exemption:	No
Used oil fuel burner:	No

CITY OF CHICAGO/ABANDONED PROPERTY (Continued) **1004698378**

Used oil processor: No
User oil refiner: No
Used oil fuel marketer to burner: No
Used oil Specification marketer: No
Used oil transfer facility: No
Used oil transporter: No

Violation Status: No violations found

FINDS:

Registry ID: 110009453377

Environmental Interest/Information System
RCRAInfo is a national information system that supports the Resource Conservation and Recovery Act (RCRA) program through the tracking of events and activities related to facilities that generate, transport, and treat, store, or dispose of hazardous waste. RCRAInfo allows RCRA program staff to track the notification, permit, compliance, and corrective action activities required under RCRA.

B13 **HUSSAIN, ZAFAR** **LUST** **S105743997**
North **1234 NORTH HALSTEAD** **N/A**
< 1/8 **CHICAGO, IL 60622**
0.015 mi.
80 ft. **Site 3 of 4 in cluster B**

Relative:
Higher

Actual:
589 ft.

LUST:

Incident Num:	20030173
IL EPA Id:	0316245347
Product:	Other Petro
IEMA Date:	02/07/2003
Project Manager:	Not reported
Project Manager Phone:	Not reported
Email:	Not reported
PRP Name:	Zafar Hussain
PRP Contact:	Not reported
PRP Address:	2250 North Mango
PRP City,St,Zip:	Chicago, IL 60639
PRP Phone:	3122551840
Site Classification:	Not reported
Section 57.5(g) Letter:	P.A.
Non LUST Determination Letter:	Not reported
20 Report Received:	Not reported
45 Report Received:	Not reported
Section 57.5(g) Letter:	Not reported
NFA/NFR Letter:	**Not reported**
NFR Date Recorded:	Not reported

14
SW
< 1/8
0.030 mi.
159 ft.

DIGITAL HUB
1040 N HALSTED ST
CHICAGO, IL 60622

RCRA-SQG **1010563451**
ILR000148627

Relative:
Lower

Actual:
580 ft.

RCRA-SQG:

Date form received by agency:	08/22/2007
Facility name:	DIGITAL HUB
Facility address:	1040 N HALSTED ST CHICAGO, IL 60622
EPA ID:	ILR000148627
Contact:	KEVIN SULLIVAN
Contact address:	Not reported Not reported
Contact country:	Not reported
Contact telephone:	(312) 943-6161
Contact email:	Not reported
EPA Region:	05
Classification:	Small Small Quantity Generator
Description:	Handler: generates more than 100 and less than 1000 kg of hazardous waste during any calendar month and accumulates less than 6000 kg of hazardous waste at any time; or generates 100 kg or less of hazardous waste during any calendar month, and accumulates more than 1000 kg of hazardous waste at any time

Owner/Operator Summary:

Owner/operator name:	DIGITAL HUB
Owner/operator address:	1040 N HALSTED ST CHICAGO, IL 60622
Owner/operator country:	US
Owner/operator telephone:	Not reported
Legal status:	Private
Owner/Operator Type:	Operator
Owner/Op start date:	08/22/2007
Owner/Op end date:	Not reported

Owner/operator name:	DIGITAL HUB
Owner/operator address:	1040 N HALSTED ST CHICAGO, IL 60622
Owner/operator country:	US
Owner/operator telephone:	Not reported
Legal status:	Private
Owner/Operator Type:	Owner
Owner/Op start date:	08/22/2007
Owner/Op end date:	Not reported

Handler Activities Summary:

U.S. importer of hazardous waste:	No
Mixed waste (haz. and radioactive):	No
Recycler of hazardous waste:	No
Transporter of hazardous waste:	No
Treater, storer or disposer of HW:	No
Underground injection activity:	No
On-site burner exemption:	No
Furnace exemption:	No
Used oil fuel burner:	No
Used oil processor:	No

DIGITAL HUB (Continued) **1010563451**

User oil refiner: No
Used oil fuel marketer to burner: No
Used oil Specification marketer: No
Used oil transfer facility: No
Used oil transporter: No

Hazardous Waste Summary:
Waste code: D001
Waste name: IGNITABLE HAZARDOUS WASTES ARE THOSE WASTES WHICH HAVE A FLASHPOINT OF LESS THAN 140 DEGREES FAHRENHEIT AS DETERMINED BY A PENSKY-MARTENS CLOSED CUP FLASH POINT TESTER. ANOTHER METHOD OF DETERMINING THE FLASH POINT OF A WASTE IS TO REVIEW THE MATERIAL SAFETY DATA SHEET, WHICH CAN BE OBTAINED FROM THE MANUFACTURER OR DISTRIBUTOR OF THE MATERIAL. LACQUER THINNER IS AN EXAMPLE OF A COMMONLY USED SOLVENT WHICH WOULD BE CONSIDERED AS IGNITABLE HAZARDOUS WASTE.

Waste code: F003
Waste name: THE FOLLOWING SPENT NON-HALOGENATED SOLVENTS: XYLENE, ACETONE, ETHYL ACETATE, ETHYL BENZENE, ETHYL ETHER, METHYL ISOBUTYL KETONE, N-BUTYL ALCOHOL, CYCLOHEXANONE, AND METHANOL; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, ONLY THE ABOVE SPENT NON-HALOGENATED SOLVENTS; AND ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, ONE OR MORE OF THE ABOVE NON-HALOGENATED SOLVENTS, AND, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THOSE SOLVENTS LISTED IN F001, F002, F004, AND F005, AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.

Violation Status: No violations found

B15 **MOBIL GAS & MINI MART** **UST** **U003888408**
North **1234 N. HALSTED** **N/A**
< 1/8 **CHICAGO, IL 60622**
0.043 mi.
229 ft. **Site 4 of 4 in cluster B**

Relative:
Higher

Actual:
590 ft.

UST:
Facility ID: 2041461
Facility Status: Active
Facility Type: **Self-Service Station**
Owner Name: Mobil Gas & Mini-Mart
Owner Id: U0034138
Owner Address: 1234 N. Halsted
Owner City,St,Zip: Chicago, IL 60622

Tank Number: 1
Tank Capacity: 10000
Tank Substance: Heating Oil
Last Used Date: 12/31/1973
OSFM First Notify Date: Not reported
Tank Status: **Exempt from registration**
Red Tag Issue Date: Not reported
Install Date: Not reported
Green Tag Decal: **K003591**
Green Tag Issue Date: **7/9/2009**
Green Tag Expire Date: **12/31/2011**
Self Service Permit Inspection Date: **Not reported**
Self Service Permit Expire Date: **Not reported**

MOBIL GAS & MINI MART (Continued) **U003888408**

Fee Due: Not reported

Tank Number: 2
Tank Capacity: 12000
Tank Substance: Gasoline
Last Used Date: Not reported
OSFM First Notify Date: 5/3/2007
Tank Status: Currently in use
Red Tag Issue Date: Not reported
Install Date: 1/28/2003
Green Tag Decal: K003591
Green Tag Issue Date: 7/9/2009
Green Tag Expire Date: 12/31/2011
Self Service Permit Inspection Date: Not reported
Self Service Permit Expire Date: Not reported
Fee Due: No

Tank Number: 3
Tank Capacity: 8000
Tank Substance: Gasoline
Last Used Date: Not reported
OSFM First Notify Date: 5/3/2007
Tank Status: Currently in use
Red Tag Issue Date: Not reported
Install Date: 1/28/2003
Green Tag Decal: K003591
Green Tag Issue Date: 7/9/2009
Green Tag Expire Date: 12/31/2011
Self Service Permit Inspection Date: Not reported
Self Service Permit Expire Date: Not reported
Fee Due: No

Tank Number: 4
Tank Capacity: 7000
Tank Substance: Diesel Fuel
Last Used Date: Not reported
OSFM First Notify Date: 5/3/2007
Tank Status: Currently in use
Red Tag Issue Date: Not reported
Install Date: 1/28/2003
Green Tag Decal: K003591
Green Tag Issue Date: 7/9/2009
Green Tag Expire Date: 12/31/2011
Self Service Permit Inspection Date: Not reported
Self Service Permit Expire Date: Not reported
Fee Due: No

Tank Number: 5
Tank Capacity: 2000
Tank Substance: Heating Oil
Last Used Date: 12/31/1973
OSFM First Notify Date: Not reported
Tank Status: Exempt from registration

MOBIL GAS & MINI MART (Continued) **U003888408**

Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**K003591**
Green Tag Issue Date:	**7/9/2009**
Green Tag Expire Date:	**12/31/2011**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

D16 **FORMER SPANJER BROTHERS SITE** **UST** **U000865886**
ENE **645 W ELM ST** **N/A**
< 1/8 **CHICAGO, IL 60610**
0.046 mi.
244 ft. **Site 1 of 7 in cluster D**

Relative:
Higher

Actual:
585 ft.

UST:

Facility ID:	2030519
Facility Status:	Closed
Facility Type:	**Other**
Owner Name:	Melk Development Mcl
Owner Id:	U0024603
Owner Address:	1337 W Fullerton Ave Sedgwick L P Scott
Owner City,St,Zip:	Chicago, IL 60614

Tank Number:	1
Tank Capacity:	3000
Tank Substance:	Heating Oil
Last Used Date:	Not reported
OSFM First Notify Date:	6/25/1992
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	2
Tank Capacity:	3000
Tank Substance:	Heating Oil
Last Used Date:	Not reported
OSFM First Notify Date:	6/25/1992
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	3
Tank Capacity:	2000

FORMER SPANJER BROTHERS SITE (Continued) **U000865886**

Tank Substance:	Heating Oil
Last Used Date:	Not reported
OSFM First Notify Date:	6/25/1992
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	4
Tank Capacity:	2000
Tank Substance:	Not reported
Last Used Date:	12/1/1979
OSFM First Notify Date:	6/25/1992
Tank Status:	**Exempt from registration**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	5
Tank Capacity:	2000
Tank Substance:	Heating Oil
Last Used Date:	12/1/1979
OSFM First Notify Date:	6/25/1992
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	6
Tank Capacity:	2000
Tank Substance:	Heating Oil
Last Used Date:	12/1/1979
OSFM First Notify Date:	6/25/1992
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**

FORMER SPANJER BROTHERS SITE (Continued) **U000865886**

Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	7
Tank Capacity:	3000
Tank Substance:	Not reported
Last Used Date:	12/1/1979
OSFM First Notify Date:	6/25/1992
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

E17 **PEOPLES GAS LASALLE CHESTNUT PROPERTY** **SRP** **S108048338**
SSE **1040 NORTH KINGSBURY STREET** **N/A**
< 1/8 **CHICAGO, IL 60610**
0.053 mi.
278 ft. **Site 1 of 2 in cluster E**

Relative: **Lower**

Actual: **581 ft.**

SRP:

IL EPA Id:	0316085749
US EPA Id:	Not reported
Longitude:	-87.646299999999997
Latitude:	41.901069999999997
Contact Name:	Steven Matuszak
Contact Address:	130 East Randolph Drive
Contact Address2:	22nd Floor
Contact City,St,Zip:	Chicago, IL 60601-
Contact Phone:	(312) 240-4648
Date Enrolled:	06/22/2006
Point Of Contact:	Joan V. Gonzalev
Consultant Company:	Burns & McDonnell
Consultant Address:	1431 Opus Place
Consultant Address2:	Suite 400
Consultant City,St,Zip:	Downers Grove, IL 60515-1164
Consultant Phone:	(630) 724-3226
Proj Mgr Assigned:	Seul
Sec. 4 Letter Date:	Not reported
NFR Recorded:	Not reported
Active:	False
Total Acres:	1.5
No Further Remediation Letter Dt:	Not reported
Remediation Applicant Co:	Peoples Gas Light & Coke Company
Remediation Applicant Title:	Mr.
Remediation Applicant Name:	Not reported
Remediation Applicant Company:	Not reported
Remediation Applicant Address:	Not reported
Remediation Applicant Address 2:	Not reported
Remediation Applicant City,St,Zip:	Not reported
Illinois EPA:	Not reported
Site Name:	Not reported

PEOPLES GAS LASALLE CHESTNUT PROPERTY (Continued) **S108048338**

NFR Letter:	Not reported
NFR Letter Date Recorded:	Not reported
Site Type:	Not reported
Comprehensive/Focused:	Not reported
Institutional Controls:	Not reported
Barrier:	Not reported
Worker Caution:	Not reported
Acres:	Not reported

F18 **FEDERAL EXPRESS CORP** **RCRA-SQG 1000462561**
West **875 W DIVISION** **FINDS ILD984807081**
< 1/8 **CHICAGO, IL 60622** **LUST**
0.061 mi. **MANIFEST**
322 ft. **Site 1 of 7 in cluster F**

Relative: Lower

Actual: 581 ft.

RCRA-SQG:

Date form received by agency:	02/26/1998
Facility name:	FEDERAL EXPRESS GYY
Facility address:	875 W DIVISION CHICAGO, IL 60622
EPA ID:	ILD984807081
Contact:	PAT VALLONE
Contact address:	875 W DIVISION CHICAGO, IL 60622
Contact country:	US
Contact telephone:	(312) 867-5881
Contact email:	Not reported
EPA Region:	05
Classification:	Small Small Quantity Generator
Description:	Handler: generates more than 100 and less than 1000 kg of hazardous waste during any calendar month and accumulates less than 6000 kg of hazardous waste at any time; or generates 100 kg or less of hazardous waste during any calendar month, and accumulates more than 1000 kg of hazardous waste at any time

Owner/Operator Summary:

Owner/operator name:	FEDERAL EXPRESS
Owner/operator address:	3975 AIRWAYS BLVD MOD E 1ST FL MEMPHIS, TN 38116
Owner/operator country:	Not reported
Owner/operator telephone:	(901) 397-4385
Legal status:	Private
Owner/Operator Type:	Owner
Owner/Op start date:	Not reported
Owner/Op end date:	Not reported

Handler Activities Summary:

U.S. importer of hazardous waste:	No
Mixed waste (haz. and radioactive):	No
Recycler of hazardous waste:	No
Transporter of hazardous waste:	No
Treater, storer or disposer of HW:	No
Underground injection activity:	No
On-site burner exemption:	No
Furnace exemption:	No
Used oil fuel burner:	No

FEDERAL EXPRESS CORP (Continued) **1000462561**

Used oil processor:	No
User oil refiner:	No
Used oil fuel marketer to burner:	No
Used oil Specification marketer:	No
Used oil transfer facility:	No
Used oil transporter:	No

Hazardous Waste Summary:

Waste code:	D001
Waste name:	IGNITABLE HAZARDOUS WASTES ARE THOSE WASTES WHICH HAVE A FLASHPOINT OF LESS THAN 140 DEGREES FAHRENHEIT AS DETERMINED BY A PENSKY-MARTENS CLOSED CUP FLASH POINT TESTER. ANOTHER METHOD OF DETERMINING THE FLASH POINT OF A WASTE IS TO REVIEW THE MATERIAL SAFETY DATA SHEET, WHICH CAN BE OBTAINED FROM THE MANUFACTURER OR DISTRIBUTOR OF THE MATERIAL. LACQUER THINNER IS AN EXAMPLE OF A COMMONLY USED SOLVENT WHICH WOULD BE CONSIDERED AS IGNITABLE HAZARDOUS WASTE.

Violation Status: No violations found

FINDS:

Registry ID: 110005881233

Environmental Interest/Information System

ACES (Illinois - Agency Compliance And Enforcement System) is the Illinois EPA Project to facilitate the permitting operations

RCRAInfo is a national information system that supports the Resource Conservation and Recovery Act (RCRA) program through the tracking of events and activities related to facilities that generate, transport, and treat, store, or dispose of hazardous waste. RCRAInfo allows RCRA program staff to track the notification, permit, compliance, and corrective action activities required under RCRA.

LUST:

Incident Num:	891195
IL EPA Id:	0316240016
Product:	Fuel Oil
IEMA Date:	07/11/1989
Project Manager:	Gaydosh
Project Manager Phone:	(217) 785-0231
Email:	Jay.Gaydosh@illinois.gov
PRP Name:	Federal Express
PRP Contact:	Ivan Detwiller
PRP Address:	1100 Lake Cook Rd., Property Dept.
PRP City,St,Zip:	Buffalo Grove, IL 60089
PRP Phone:	Not reported
Site Classification:	Not reported
Section 57.5(g) Letter:	731
Non LUST Determination Letter:	Not reported
20 Report Received:	Not reported
45 Report Received:	05/25/1994
Section 57.5(g) Letter:	Not reported
NFA/NFR Letter:	**09/20/2000**
NFR Date Recorded:	Not reported

FEDERAL EXPRESS CORP (Continued) **1000462561**

NY MANIFEST:

EPA ID:	ILD984807081
Country:	USA
Mailing Name:	FEDERAL EXPRESS
Mailing Contact:	STEVE ZEBOVITZ
Mailing Address:	1100 LAKE COOK ROAD
Mailing Address 2:	Not reported
Mailing City:	BUFFALO GROVE
Mailing State:	IL
Mailing Zip:	60089
Mailing Zip4:	Not reported
Mailing Country:	USA
Mailing Phone:	708-759-9493

Document ID:	NYB8371278
Manifest Status:	Completed after the designated time period for a TSDF to get a copy to the DEC
Trans1 State ID:	NY67300K
Trans2 State ID:	Not reported
Generator Ship Date:	961024
Trans1 Recv Date:	961024
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	961028
Part A Recv Date:	961129
Part B Recv Date:	961118
Generator EPA ID:	ILD984807081
Trans1 EPA ID:	NYD000688671
Trans2 EPA ID:	Not reported
TSDF ID:	NYD049836679
Waste Code:	B007 - OTHER MISCELLANEOUS PCB WASTES
Quantity:	18570
Units:	K - Kilograms (2.2 pounds)
Number of Containers:	001
Container Type:	DT - Dump trucks
Handling Method:	L Landfill.
Specific Gravity:	100
Year:	96

Document ID:	NYB8371224
Manifest Status:	Completed copy
Trans1 State ID:	NY67282K
Trans2 State ID:	Not reported
Generator Ship Date:	961024
Trans1 Recv Date:	961024
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	961025
Part A Recv Date:	961129
Part B Recv Date:	961108
Generator EPA ID:	ILD984807081
Trans1 EPA ID:	NYD000688671
Trans2 EPA ID:	Not reported
TSDF ID:	NYD049836679
Waste Code:	B007 - OTHER MISCELLANEOUS PCB WASTES
Quantity:	21628
Units:	K - Kilograms (2.2 pounds)
Number of Containers:	001

FEDERAL EXPRESS CORP (Continued) **1000462561**

Container Type: DT - Dump trucks
Handling Method: L Landfill.
Specific Gravity: 100
Year: 96

Document ID: NYB8371215
Manifest Status: Completed copy
Trans1 State ID: NY67277K
Trans2 State ID: Not reported
Generator Ship Date: 961024
Trans1 Recv Date: 961024
Trans2 Recv Date: Not reported
TSD Site Recv Date: 961025
Part A Recv Date: 961129
Part B Recv Date: 961113
Generator EPA ID: ILD984807081
Trans1 EPA ID: NYD000688671
Trans2 EPA ID: Not reported
TSDF ID: NYD049836679
Waste Code: B007 - OTHER MISCELLANEOUS PCB WASTES
Quantity: 20122
Units: K - Kilograms (2.2 pounds)
Number of Containers: 001
Container Type: DT - Dump trucks
Handling Method: L Landfill.
Specific Gravity: 100
Year: 96

Document ID: NYB8371242
Manifest Status: Completed copy
Trans1 State ID: NY67286K
Trans2 State ID: Not reported
Generator Ship Date: 961024
Trans1 Recv Date: 961024
Trans2 Recv Date: Not reported
TSD Site Recv Date: 961025
Part A Recv Date: 961129
Part B Recv Date: 961113
Generator EPA ID: ILD984807081
Trans1 EPA ID: NYD000688671
Trans2 EPA ID: Not reported
TSDF ID: NYD049836679
Waste Code: B007 - OTHER MISCELLANEOUS PCB WASTES
Quantity: 19940
Units: K - Kilograms (2.2 pounds)
Number of Containers: 001
Container Type: DT - Dump trucks
Handling Method: L Landfill.
Specific Gravity: 100
Year: 96

Document ID: NYB8371287
Manifest Status: Completed copy
Trans1 State ID: NY67284K

FEDERAL EXPRESS CORP (Continued) **1000462561**

Trans2 State ID:	Not reported
Generator Ship Date:	961024
Trans1 Recv Date:	961024
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	961025
Part A Recv Date:	961129
Part B Recv Date:	961113
Generator EPA ID:	ILD984807081
Trans1 EPA ID:	NYD000688671
Trans2 EPA ID:	Not reported
TSDF ID:	NYD049836679
Waste Code:	B007 - OTHER MISCELLANEOUS PCB WASTES
Quantity:	20911
Units:	K - Kilograms (2.2 pounds)
Number of Containers:	001
Container Type:	DT - Dump trucks
Handling Method:	L Landfill.
Specific Gravity:	100
Year:	96

Document ID:	NYB8371269
Manifest Status:	Completed copy
Trans1 State ID:	NY67285K
Trans2 State ID:	Not reported
Generator Ship Date:	961024
Trans1 Recv Date:	961024
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	961025
Part A Recv Date:	961129
Part B Recv Date:	961113
Generator EPA ID:	ILD984807081
Trans1 EPA ID:	NYD000688671
Trans2 EPA ID:	Not reported
TSDF ID:	NYD049836679
Waste Code:	B007 - OTHER MISCELLANEOUS PCB WASTES
Quantity:	21065
Units:	K - Kilograms (2.2 pounds)
Number of Containers:	001
Container Type:	DT - Dump trucks
Handling Method:	L Landfill.
Specific Gravity:	100
Year:	96

Document ID:	NYB8371233
Manifest Status:	Completed copy
Trans1 State ID:	NY67280K
Trans2 State ID:	Not reported
Generator Ship Date:	961024
Trans1 Recv Date:	961024
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	961025
Part A Recv Date:	961129
Part B Recv Date:	961113
Generator EPA ID:	ILD984807081
Trans1 EPA ID:	NYD000688671

FEDERAL EXPRESS CORP (Continued) **1000462561**

Trans2 EPA ID:	Not reported
TSDF ID:	NYD049836679
Waste Code:	B007 - OTHER MISCELLANEOUS PCB WASTES
Quantity:	19360
Units:	K - Kilograms (2.2 pounds)
Number of Containers:	001
Container Type:	DT - Dump trucks
Handling Method:	L Landfill.
Specific Gravity:	100
Year:	96

Document ID:	NYB8371251
Manifest Status:	Completed after the designated time period for a TSDF to get a copy to the DEC
Trans1 State ID:	NY67301KN
Trans2 State ID:	Not reported
Generator Ship Date:	961024
Trans1 Recv Date:	961024
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	961028
Part A Recv Date:	961129
Part B Recv Date:	961120
Generator EPA ID:	ILD984807081
Trans1 EPA ID:	NYD000688671
Trans2 EPA ID:	Not reported
TSDF ID:	NYD049836679
Waste Code:	B007 - OTHER MISCELLANEOUS PCB WASTES
Quantity:	19786
Units:	K - Kilograms (2.2 pounds)
Number of Containers:	001
Container Type:	DT - Dump trucks
Handling Method:	L Landfill.
Specific Gravity:	100
Year:	96

F19 **FEDERAL EXPRESS CORPORATION** **SRP** **S104491597**
West **875 WEST DIVISION STREET** **N/A**
< 1/8 **CHICAGO, IL 60622**
0.061 mi.
322 ft. **Site 2 of 7 in cluster F**

Relative:
Lower

Actual:
581 ft.

SRP:

IL EPA Id:	0316240016
US EPA Id:	ILD984807081
Longitude:	-87.649510000000006
Latitude:	41.902500000000003
Contact Name:	Steven Zebovitz
Contact Address:	1100 Lake Cook Road
Contact Address2:	Not reported
Contact City,St,Zip:	Chicago, IL 60089
Contact Phone:	(708) 215-4249
Date Enrolled:	05/03/1996
Point Of Contact:	Jack Dowden
Consultant Company:	Montgomery Watson
Consultant Address:	2100 Corporate Drive
Consultant Address2:	Not reported
Consultant City,St,Zip:	Addison, IL 60101
Consultant Phone:	(630) 691-5000

FEDERAL EXPRESS CORPORATION (Continued) **S104491597**

Proj Mgr Assigned:	L-Gaydosh
Sec. 4 Letter Date:	Not reported
NFR Recorded:	2000-10-12
Active:	False
Total Acres:	4.599
No Further Remediation Letter Dt:	2000-09-20
Remediation Applicant Co:	Federal Express Corporation
Remediation Applicant Title:	Mr.
Remediation Applicant Name:	Mr. Steven Zebovitz
Remediation Applicant Company:	Federal Express
Remediation Applicant Address:	1100 Lake Cook Road
Remediation Applicant Address 2:	Not reported
Remediation Applicant City,St,Zip:	Buffalo Grove, IL 60089-
Illinois EPA:	0316240016
Site Name:	Federal Express Corporation
NFR Letter:	2000-09-20 00:00:00
NFR Letter Date Recorded:	2000-10-12 00:00:00
Site Type:	Industrial/Commercial
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Not reported
Barrier:	Not reported
Worker Caution:	False
Acres:	4.599

E20
SSE
< 1/8
0.061 mi.
323 ft.

Relative:
Lower

Actual:
581 ft.

PEOPLES GAS AND LIGHT **Manufactured Gas Plants** **1008407349**
NW CORNER CROSBY AND HOBBIE **N/A**
CHICAGO, IL 60610

Site 2 of 2 in cluster E

Manufactured Gas Plants:
No additional information available

F21
West
< 1/8
0.061 mi.
323 ft.

Relative:
Lower

Actual:
581 ft.

FEDERAL EXPRESS CORP **UST** **U001142447**
875 W DIVISION GOOSE ISLAND SITE **N/A**
CHICAGO, IL 60622

Site 3 of 7 in cluster F

UST:

Facility ID:	2029435
Facility Status:	Closed
Facility Type:	**Other**
Owner Name:	Federal Express Corporation
Owner Id:	U0018137
Owner Address:	3620 Hacks Cross Road, Bldg. 2, 2nd Floor
Owner City,St,Zip:	Memphis, TN 38125
Tank Number:	1
Tank Capacity:	12000
Tank Substance:	Gasoline
Last Used Date:	11/1/1982
OSFM First Notify Date:	2/24/1992

FEDERAL EXPRESS CORP (Continued) **U001142447**

Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1902
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	2
Tank Capacity:	12000
Tank Substance:	Gasoline
Last Used Date:	11/1/1982
OSFM First Notify Date:	2/24/1992
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1902
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	3
Tank Capacity:	12000
Tank Substance:	Diesel Fuel
Last Used Date:	11/1/1982
OSFM First Notify Date:	2/24/1992
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1902
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	4
Tank Capacity:	500
Tank Substance:	Not reported
Last Used Date:	11/1/1982
OSFM First Notify Date:	2/24/1992
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1902
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

FEDERAL EXPRESS CORP (Continued) **U001142447**

Tank Number:	5
Tank Capacity:	500
Tank Substance:	Not reported
Last Used Date:	11/1/1982
OSFM First Notify Date:	2/24/1992
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1902
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	6
Tank Capacity:	2000
Tank Substance:	Diesel Fuel
Last Used Date:	11/1/1982
OSFM First Notify Date:	9/9/1996
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1902
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	7
Tank Capacity:	2000
Tank Substance:	Gasoline
Last Used Date:	11/1/1982
OSFM First Notify Date:	9/9/1996
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1902
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	8
Tank Capacity:	1000
Tank Substance:	Heating Oil
Last Used Date:	11/1/1982
OSFM First Notify Date:	9/9/1996
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1902
Green Tag Decal:	**Not reported**

FEDERAL EXPRESS CORP (Continued) **U001142447**

Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	9
Tank Capacity:	500
Tank Substance:	Heating Oil
Last Used Date:	11/1/1982
OSFM First Notify Date:	10/11/1996
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1902
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

D22 **VACANT LOT** **UST** **U003668660**
ENE **1116 N HOWE ST** **N/A**
< 1/8 **CHICAGO, IL 60622**
0.064 mi.
340 ft. **Site 2 of 7 in cluster D**

Relative:
Higher

Actual:
586 ft.

UST:

Facility ID:	2038794
Facility Status:	Exempt
Facility Type:	**Commercial / Retail**
Owner Name:	MCL Construction Corp
Owner Id:	U0028616
Owner Address:	455 E Illinois St
Owner City,St,Zip:	Chicago, IL 60611

Tank Number:	1
Tank Capacity:	8000
Tank Substance:	Gasoline
Last Used Date:	12/31/1973
OSFM First Notify Date:	5/6/1999
Tank Status:	**Exempt from registration**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

F23
West
< 1/8
0.072 mi.
379 ft.

STUART DEAN CO INC
870 W DIVISION ST STE F
CHICAGO, IL 60622

Site 4 of 7 in cluster F

RCRA-SQG **1001485148**
FINDS **ILR000063347**

Relative:
Lower

Actual:
581 ft.

RCRA-SQG:

Date form received by agency:	04/12/1999
Facility name:	STUART DEAN CO INC
Facility address:	870 W DIVISION ST STE F CHICAGO, IL 60622
EPA ID:	ILR000063347
Contact:	ANDREW GRZEBIEN
Contact address:	870 W DIVISION ST STE F CHICAGO, IL 60622
Contact country:	US
Contact telephone:	(800) 421-4935
Contact email:	Not reported
EPA Region:	05
Classification:	Small Small Quantity Generator
Description:	Handler: generates more than 100 and less than 1000 kg of hazardous waste during any calendar month and accumulates less than 6000 kg of hazardous waste at any time; or generates 100 kg or less of hazardous waste during any calendar month, and accumulates more than 1000 kg of hazardous waste at any time

Owner/Operator Summary:

Owner/operator name:	STUART DEAN CO INC
Owner/operator address:	870 W DIVISION ST STE F CHICAGO, IL 60622
Owner/operator country:	Not reported
Owner/operator telephone:	(800) 421-4935
Legal status:	Private
Owner/Operator Type:	Owner
Owner/Op start date:	Not reported
Owner/Op end date:	Not reported

Handler Activities Summary:

U.S. importer of hazardous waste:	No
Mixed waste (haz. and radioactive):	No
Recycler of hazardous waste:	No
Transporter of hazardous waste:	No
Treater, storer or disposer of HW:	No
Underground injection activity:	No
On-site burner exemption:	No
Furnace exemption:	No
Used oil fuel burner:	No
Used oil processor:	No
User oil refiner:	No
Used oil fuel marketer to burner:	No
Used oil Specification marketer:	No
Used oil transfer facility:	No
Used oil transporter:	No

Hazardous Waste Summary:

Waste code:	D001
Waste name:	IGNITABLE HAZARDOUS WASTES ARE THOSE WASTES WHICH HAVE A FLASHPOINT OF LESS THAN 140 DEGREES FAHRENHEIT AS DETERMINED BY A PENSKY-MARTENS

STUART DEAN CO INC (Continued) **1001485148**

CLOSED CUP FLASH POINT TESTER. ANOTHER METHOD OF DETERMINING THE FLASH POINT OF A WASTE IS TO REVIEW THE MATERIAL SAFETY DATA SHEET, WHICH CAN BE OBTAINED FROM THE MANUFACTURER OR DISTRIBUTOR OF THE MATERIAL. LACQUER THINNER IS AN EXAMPLE OF A COMMONLY USED SOLVENT WHICH WOULD BE CONSIDERED AS IGNITABLE HAZARDOUS WASTE.

Waste code: F003
Waste name: THE FOLLOWING SPENT NON-HALOGENATED SOLVENTS: XYLENE, ACETONE, ETHYL ACETATE, ETHYL BENZENE, ETHYL ETHER, METHYL ISOBUTYL KETONE, N-BUTYL ALCOHOL, CYCLOHEXANONE, AND METHANOL; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, ONLY THE ABOVE SPENT NON-HALOGENATED SOLVENTS; AND ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, ONE OR MORE OF THE ABOVE NON-HALOGENATED SOLVENTS, AND, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THOSE SOLVENTS LISTED IN F001, F002, F004, AND F005, AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.

Waste code: F005
Waste name: THE FOLLOWING SPENT NON-HALOGENATED SOLVENTS: TOLUENE, METHYL ETHYL KETONE, CARBON DISULFIDE, ISOBUTANOL, PYRIDINE, BENZENE, 2-ETHOXYETHANOL, AND 2-NITROPROPANE; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THE ABOVE NON-HALOGENATED SOLVENTS OR THOSE SOLVENTS LISTED IN F001, F002, OR F004; AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.

Violation Status: No violations found

FINDS:

Registry ID: 110003050313

Environmental Interest/Information System

ACES (Illinois - Agency Compliance And Enforcement System) is the Illinois EPA Project to facilitate the permitting operations

RCRAInfo is a national information system that supports the Resource Conservation and Recovery Act (RCRA) program through the tracking of events and activities related to facilities that generate, transport, and treat, store, or dispose of hazardous waste. RCRAInfo allows RCRA program staff to track the notification, permit, compliance, and corrective action activities required under RCRA.

D24 **SPANJER BROTHERS INC** **UST U001143163**
ENE **1155 N HOWE ST** **N/A**
< 1/8 **CHICAGO, IL 60610**
0.080 mi.
424 ft. **Site 3 of 7 in cluster D**

Relative:
Higher

Actual:
586 ft.

UST:
Facility ID: 2030518
Facility Status: Closed
Facility Type: **Industrial / Manufacturing**
Owner Name: Spanjer Brothers Inc
Owner Id: U0019980
Owner Address: 1155 N Howe St

SPANJER BROTHERS INC (Continued) **U001143163**

Owner City,St,Zip:	Chicago, IL 60610
Tank Number:	1
Tank Capacity:	5000
Tank Substance:	Heating Oil
Last Used Date:	Not reported
OSFM First Notify Date:	6/25/1992
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1967
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

D25 **SPANJER BROTHERS INC.** **LUST** **S104523745**
ENE **1155 NORTH HOWE** **N/A**
< 1/8 **CHICAGO, IL 60610**
0.080 mi.
424 ft. **Site 4 of 7 in cluster D**

Relative: **Higher**

Actual: **586 ft.**

LUST:

Incident Num:	932001
IL EPA Id:	0316085198
Product:	Fuel Oil
IEMA Date:	07/27/1993
Project Manager:	Harlow
Project Manager Phone:	(217) 524-7650
Email:	Robert.Harlow@illinois.gov
PRP Name:	Spanjer Brothers Inc.
PRP Contact:	Jim Frycek
PRP Address:	1160 North Howe
PRP City,St,Zip:	Chicago, IL 60610
PRP Phone:	Not reported
Site Classification:	Not reported
Section 57.5(g) Letter:	731
Non LUST Determination Letter:	Not reported
20 Report Received:	08/23/1993
45 Report Received:	08/26/1993
Section 57.5(g) Letter:	Not reported
NFA/NFR Letter:	**09/07/1993**
NFR Date Recorded:	Not reported

D26 **FORMER SPANJER BROTHERS SITE** **UST** **U003104600**
ENE **1160 N HOWE** **N/A**
< 1/8 **CHICAGO, IL 60610**
0.081 mi.
426 ft. **Site 5 of 7 in cluster D**

Relative: **Higher**

Actual: **586 ft.**

UST:

Facility ID:	2034811
Facility Status:	Closed
Facility Type:	**Other**
Owner Name:	Melk Development Mcl

FORMER SPANJER BROTHERS SITE (Continued) **U003104600**

Owner Id:	U0024603
Owner Address:	1337 W Fullerton Ave Sedgwick L P Scott
Owner City,St,Zip:	Chicago, IL 60614
Tank Number:	1
Tank Capacity:	5000
Tank Substance:	Heating Oil
Last Used Date:	Not reported
OSFM First Notify Date:	3/8/1996
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1902
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

D27 **CITY OF CHICAGO/ABANDONED PROPERTY** **RCRA-CESQG** **1004698379**
ENE **1160 N HOWE ST** **FINDS** **ILR000106260**
< 1/8 **CHICAGO, IL 60610**
0.081 mi.
426 ft. **Site 6 of 7 in cluster D**

Relative:
Higher

Actual:
586 ft.

RCRA-CESQG:

Date form received by agency:	06/01/2001
Facility name:	CITY OF CHICAGO/ABANDONED PROPERTY
Facility address:	1160 N HOWE ST CHICAGO, IL 60610
EPA ID:	ILR000106260
Mailing address:	30 N LASALLE 25TH FLR CHICAGO, IL 60601
Contact:	PETE BADILLO
Contact address:	30 N LASALLE 25TH FLR CHICAGO, IL 60601
Contact country:	US
Contact telephone:	(312) 656-6992
Contact email:	Not reported
EPA Region:	05
Classification:	Conditionally Exempt Small Quantity Generator
Description:	Handler: generates 100 kg or less of hazardous waste per calendar month, and accumulates 1000 kg or less of hazardous waste at any time; or generates 1 kg or less of acutely hazardous waste per calendar month, and accumulates at any time: 1 kg or less of acutely hazardous waste; or 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste; or generates 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste during any calendar month, and accumulates at any time: 1 kg or less of acutely hazardous waste; or 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste

Owner/Operator Summary:

CITY OF CHICAGO/ABANDONED PROPERTY (Continued) **1004698379**

Owner/operator name: CITY OF CHICAGO
Owner/operator address: 30 N LASALLE 25TH FLR
CHICAGO, IL 60601
Owner/operator country: Not reported
Owner/operator telephone: (312) 656-6992
Legal status: Private
Owner/Operator Type: Owner
Owner/Op start date: 01/01/0001
Owner/Op end date: Not reported

Handler Activities Summary:
U.S. importer of hazardous waste: No
Mixed waste (haz. and radioactive): No
Recycler of hazardous waste: No
Transporter of hazardous waste: No
Treater, storer or disposer of HW: No
Underground injection activity: No
On-site burner exemption: No
Furnace exemption: No
Used oil fuel burner: No
Used oil processor: No
User oil refiner: No
Used oil fuel marketer to burner: No
Used oil Specification marketer: No
Used oil transfer facility: No
Used oil transporter: No

Violation Status: No violations found

FINDS:

Registry ID: 110009453386

Environmental Interest/Information System
RCRAInfo is a national information system that supports the Resource Conservation and Recovery Act (RCRA) program through the tracking of events and activities related to facilities that generate, transport, and treat, store, or dispose of hazardous waste. RCRAInfo allows RCRA program staff to track the notification, permit, compliance, and corrective action activities required under RCRA.

D28 **SPANJER BROS INC** **RCRA-NonGen** **1000316543**
ENE **1160 N HOWE ST** **FINDS** **ILD005161898**
< 1/8 **CHICAGO, IL 60610**
0.081 mi.
426 ft. **Site 7 of 7 in cluster D**

Relative:
Higher

Actual:
586 ft.

RCRA-NonGen:
Date form received by agency: 07/25/2007
Facility name: SPANJER BROS INC
Facility address: 1160 N HOWE ST
CHICAGO, IL 60610
EPA ID: ILD005161898
Contact: ALFRED SMITH
Contact address: 1160 N HOWE ST
CHICAGO, IL 60610
Contact country: US

SPANJER BROS INC (Continued) **1000316543**

Contact telephone: (312) 664-2900
Contact email: Not reported
EPA Region: 05
Classification: Non-Generator
Description: Handler: Non-Generators do not presently generate hazardous waste

Owner/Operator Summary:
Owner/operator name: NAME NOT REPORTED
Owner/operator address: ADDRESS NOT REPORTED
CITY NOT REPORTED, AK 99998
Owner/operator country: Not reported
Owner/operator telephone: (312) 555-1212
Legal status: Private
Owner/Operator Type: Operator
Owner/Op start date: Not reported
Owner/Op end date: Not reported

Owner/operator name: SPANJER BROS INC
Owner/operator address: ADDRESS NOT REPORTED
CITY NOT REPORTED, AK 99998
Owner/operator country: Not reported
Owner/operator telephone: (312) 555-1212
Legal status: Private
Owner/Operator Type: Owner
Owner/Op start date: Not reported
Owner/Op end date: Not reported

Handler Activities Summary:
U.S. importer of hazardous waste: No
Mixed waste (haz. and radioactive): No
Recycler of hazardous waste: No
Transporter of hazardous waste: No
Treater, storer or disposer of HW: No
Underground injection activity: No
On-site burner exemption: No
Furnace exemption: No
Used oil fuel burner: No
Used oil processor: No
User oil refiner: No
Used oil fuel marketer to burner: No
Used oil Specification marketer: No
Used oil transfer facility: No
Used oil transporter: No

Historical Generators:
Date form received by agency: 09/28/1988
Facility name: SPANJER BROS INC
Classification: Large Quantity Generator

Hazardous Waste Summary:
Waste code: D000
Waste name: Not Defined

Waste code: D001
Waste name: IGNITABLE HAZARDOUS WASTES ARE THOSE WASTES WHICH HAVE A FLASHPOINT OF

SPANJER BROS INC (Continued) **1000316543**

LESS THAN 140 DEGREES FAHRENHEIT AS DETERMINED BY A PENSKY-MARTENS CLOSED CUP FLASH POINT TESTER. ANOTHER METHOD OF DETERMINING THE FLASH POINT OF A WASTE IS TO REVIEW THE MATERIAL SAFETY DATA SHEET, WHICH CAN BE OBTAINED FROM THE MANUFACTURER OR DISTRIBUTOR OF THE MATERIAL. LACQUER THINNER IS AN EXAMPLE OF A COMMONLY USED SOLVENT WHICH WOULD BE CONSIDERED AS IGNITABLE HAZARDOUS WASTE.

Violation Status: No violations found

FINDS:

Registry ID: 110005815332

Environmental Interest/Information System
RCRAInfo is a national information system that supports the Resource Conservation and Recovery Act (RCRA) program through the tracking of events and activities related to facilities that generate, transport, and treat, store, or dispose of hazardous waste. RCRAInfo allows RCRA program staff to track the notification, permit, compliance, and corrective action activities required under RCRA.

29
SW
< 1/8
0.081 mi.
429 ft.

FEDERAL EXPRESS STATION **UST** **U003298261**
1111 N HOOKER STREET **N/A**
CHICAGO, IL 60610

Relative:
Higher

Actual:
585 ft.

UST:

Facility ID:	2036054
Facility Status:	Active
Facility Type:	**Trucking Company**
Owner Name:	Federal Express Corporation
Owner Id:	U0018137
Owner Address:	3620 Hacks Cross Road, Bldg. 2, 2nd Floor
Owner City,St,Zip:	Memphis, TN 38125
Tank Number:	1
Tank Capacity:	10000
Tank Substance:	Gasoline
Last Used Date:	Not reported
OSFM First Notify Date:	10/15/1997
Tank Status:	**Currently in use**
Red Tag Issue Date:	Not reported
Install Date:	8/27/1997
Green Tag Decal:	**L003520**
Green Tag Issue Date:	**7/7/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No
Tank Number:	2
Tank Capacity:	10000
Tank Substance:	Diesel Fuel
Last Used Date:	Not reported
OSFM First Notify Date:	10/15/1997

FEDERAL EXPRESS STATION (Continued) **U003298261**

Tank Status:	**Currently in use**
Red Tag Issue Date:	Not reported
Install Date:	8/27/1997
Green Tag Decal:	**L003520**
Green Tag Issue Date:	**7/7/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

F30 **CHICAGO TRANSIT AUTHORITY** **RCRA-CESQG 1004692570**
West **901 W DIVISION ST** **FINDS IL0000642934**
< 1/8 **CHICAGO, IL 60622**
0.085 mi.
451 ft. **Site 5 of 7 in cluster F**

Relative:
Lower

Actual:
581 ft.

RCRA-CESQG:

Date form received by agency:	01/07/1999
Facility name:	CHICAGO TRANSIT AUTHORITY
Facility address:	901 W DIVISION ST CHICAGO, IL 60622
EPA ID:	IL0000642934
Mailing address:	120 N RACINE CHICAGO, IL 60607
Contact:	GEORGE VOGELSANG
Contact address:	120 N RACINE CHICAGO, IL 60607
Contact country:	US
Contact telephone:	(312) 733-7000
Contact email:	Not reported
EPA Region:	05
Classification:	Conditionally Exempt Small Quantity Generator
Description:	Handler: generates 100 kg or less of hazardous waste per calendar month, and accumulates 1000 kg or less of hazardous waste at any time; or generates 1 kg or less of acutely hazardous waste per calendar month, and accumulates at any time: 1 kg or less of acutely hazardous waste; or 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste; or generates 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste during any calendar month, and accumulates at any time: 1 kg or less of acutely hazardous waste; or 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste

Owner/Operator Summary:

Owner/operator name:	CHICAGO TRANSIT AUTHORITY
Owner/operator address:	PO BOX 3555 CHICAGO, IL 60654
Owner/operator country:	Not reported
Owner/operator telephone:	(312) 733-7000
Legal status:	Municipal
Owner/Operator Type:	Owner
Owner/Op start date:	Not reported
Owner/Op end date:	Not reported

CHICAGO TRANSIT AUTHORITY (Continued) **1004692570**

Handler Activities Summary:
- U.S. importer of hazardous waste: No
- Mixed waste (haz. and radioactive): No
- Recycler of hazardous waste: No
- Transporter of hazardous waste: No
- Treater, storer or disposer of HW: No
- Underground injection activity: No
- On-site burner exemption: No
- Furnace exemption: No
- Used oil fuel burner: No
- Used oil processor: No
- User oil refiner: No
- Used oil fuel marketer to burner: No
- Used oil Specification marketer: No
- Used oil transfer facility: No
- Used oil transporter: No

Hazardous Waste Summary:
- Waste code: D001
- Waste name: IGNITABLE HAZARDOUS WASTES ARE THOSE WASTES WHICH HAVE A FLASHPOINT OF LESS THAN 140 DEGREES FAHRENHEIT AS DETERMINED BY A PENSKY-MARTENS CLOSED CUP FLASH POINT TESTER. ANOTHER METHOD OF DETERMINING THE FLASH POINT OF A WASTE IS TO REVIEW THE MATERIAL SAFETY DATA SHEET, WHICH CAN BE OBTAINED FROM THE MANUFACTURER OR DISTRIBUTOR OF THE MATERIAL. LACQUER THINNER IS AN EXAMPLE OF A COMMONLY USED SOLVENT WHICH WOULD BE CONSIDERED AS IGNITABLE HAZARDOUS WASTE.

- Violation Status: No violations found

FINDS:

- Registry ID: 110005804326

Environmental Interest/Information System

ACES (Illinois - Agency Compliance And Enforcement System) is the Illinois EPA Project to facilitate the permitting operations

RCRAInfo is a national information system that supports the Resource Conservation and Recovery Act (RCRA) program through the tracking of events and activities related to facilities that generate, transport, and treat, store, or dispose of hazardous waste. RCRAInfo allows RCRA program staff to track the notification, permit, compliance, and corrective action activities required under RCRA.

F31 **HOOKER DIVISION L.L.C.** **LUST** **S104522963**
West **901 DIVISION ST.** **N/A**
< 1/8 **CHICAGO, IL 60622**
0.085 mi.
451 ft. **Site 6 of 7 in cluster F**

Relative:
Lower

Actual:
581 ft.

LUST:
- Incident Num: 942080
- IL EPA Id: 0316085229
- Product: Unleaded Gas, Other Petro
- IEMA Date: 09/13/1994
- Project Manager: Harlow

HOOKER DIVISION L.L.C. (Continued) **S104522963**

Project Manager Phone:	(217) 524-7650
Email:	Robert.Harlow@illinois.gov
PRP Name:	Creative Construction Ltd.
PRP Contact:	Adrienne Pearlman
PRP Address:	400 West Huron St.
PRP City,St,Zip:	Chicago, IL 60610
PRP Phone:	Not reported
Site Classification:	Not reported
Section 57.5(g) Letter:	732
Non LUST Determination Letter:	Not reported
20 Report Received:	10/11/1994
45 Report Received:	11/28/1994
Section 57.5(g) Letter:	Not reported
NFA/NFR Letter:	**05/30/1995**
NFR Date Recorded:	Not reported

G32 **VACANT LOT** **UST** **U003668701**
ENE **1116 NORTH HOWE** **N/A**
< 1/8 **CHICAGO, IL 60622**
0.087 mi.
462 ft. **Site 1 of 2 in cluster G**

Relative: **Higher**

Actual: **586 ft.**

UST:

Facility ID:	2038844
Facility Status:	Exempt
Facility Type:	**None**
Owner Name:	MCL Construction Corp.
Owner Id:	U0028658
Owner Address:	455 East Illinois Street
Owner City,St,Zip:	Chicago, IL 60611
Tank Number:	1
Tank Capacity:	8000
Tank Substance:	Gasoline
Last Used Date:	12/31/1973
OSFM First Notify Date:	Not reported
Tank Status:	**Exempt from registration**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

F33 **HOOKER/DAVISION LLC** **UST** **U001142898**
West **901 W DIVISION ST** **N/A**
< 1/8 **CHICAGO, IL 60606**
0.088 mi.
466 ft. **Site 7 of 7 in cluster F**

Relative: **Lower**

Actual: **581 ft.**

UST:

Facility ID:	2020543
Facility Status:	Closed
Facility Type:	**None**

HOOKER/DAVISION LLC (Continued) **U001142898**

Owner Name:	Not reported
Owner Id:	Not reported
Owner Address:	Not reported
Owner City,St,Zip:	Not reported
Tank Number:	1
Tank Capacity:	15000
Tank Substance:	Not reported
Last Used Date:	1/1/1981
OSFM First Notify Date:	5/1/1986
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	2
Tank Capacity:	15000
Tank Substance:	Not reported
Last Used Date:	1/1/1981
OSFM First Notify Date:	5/1/1986
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	Not reported
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

Tank Number:	3
Tank Capacity:	1000
Tank Substance:	Gasoline
Last Used Date:	12/1/1973
OSFM First Notify Date:	10/12/1994
Tank Status:	**Exempt from registration**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1902
Green Tag Decal:	**Not reported**
Green Tag Issue Date:	**Not reported**
Green Tag Expire Date:	**Not reported**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	Not reported

34
North
< 1/8
0.092 mi.
488 ft.

CENTERMARK GRAPHICS
1333 N KINGSBURY STE 202
CHICAGO, IL 60622

RCRA-SQG
FINDS
MANIFEST

1001087052
ILR000017780

Relative:
Higher

Actual:
590 ft.

RCRA-SQG:

Date form received by agency:	03/08/1996
Facility name:	CENTERMARK GRAPHICS
Facility address:	1333 N KINGSBURY STE 202 CHICAGO, IL 60622
EPA ID:	ILR000017780
Contact:	RICHARD HARPER
Contact address:	1333 N KINGSBURY STE 202 CHICAGO, IL 60622
Contact country:	US
Contact telephone:	(312) 266-8181
Contact email:	Not reported
EPA Region:	05
Classification:	Small Small Quantity Generator
Description:	Handler: generates more than 100 and less than 1000 kg of hazardous waste during any calendar month and accumulates less than 6000 kg of hazardous waste at any time; or generates 100 kg or less of hazardous waste during any calendar month, and accumulates more than 1000 kg of hazardous waste at any time

Owner/Operator Summary:

Owner/operator name:	CENTERMARK GRAPHICS
Owner/operator address:	1333 N KINGSBURY STE 202 CHICAGO, IL 60622
Owner/operator country:	Not reported
Owner/operator telephone:	(312) 266-8181
Legal status:	Private
Owner/Operator Type:	Owner
Owner/Op start date:	Not reported
Owner/Op end date:	Not reported

Handler Activities Summary:

U.S. importer of hazardous waste:	No
Mixed waste (haz. and radioactive):	No
Recycler of hazardous waste:	No
Transporter of hazardous waste:	No
Treater, storer or disposer of HW:	No
Underground injection activity:	No
On-site burner exemption:	No
Furnace exemption:	No
Used oil fuel burner:	No
Used oil processor:	No
User oil refiner:	No
Used oil fuel marketer to burner:	No
Used oil Specification marketer:	No
Used oil transfer facility:	No
Used oil transporter:	No

Hazardous Waste Summary:

Waste code:	D000
Waste name:	Not Defined

CENTERMARK GRAPHICS (Continued) **1001087052**

Waste code: D002
Waste name: A WASTE WHICH HAS A PH OF LESS THAN 2 OR GREATER THAN 12.5 IS CONSIDERED TO BE A CORROSIVE HAZARDOUS WASTE. SODIUM HYDROXIDE, A CAUSTIC SOLUTION WITH A HIGH PH, IS OFTEN USED BY INDUSTRIES TO CLEAN OR DEGREASE PARTS. HYDROCHLORIC ACID, A SOLUTION WITH A LOW PH, IS USED BY MANY INDUSTRIES TO CLEAN METAL PARTS PRIOR TO PAINTING. WHEN THESE CAUSTIC OR ACID SOLUTIONS BECOME CONTAMINATED AND MUST BE DISPOSED, THE WASTE WOULD BE A CORROSIVE HAZARDOUS WASTE.

Waste code: D011
Waste name: SILVER

Violation Status: No violations found

FINDS:

Registry ID: 110005941785

Environmental Interest/Information System

ACES (Illinois - Agency Compliance And Enforcement System) is the Illinois EPA Project to facilitate the permitting operations

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NY MANIFEST:

EPA ID: ILR000017780
Country: USA
Mailing Name: CENTERMARK GRAPHICS
Mailing Contact: CENTERMARK GRAPHICS
Mailing Address: 1333 N KINGSBURY
Mailing Address 2: Not reported
Mailing City: CHICAGO
Mailing State: IL
Mailing Zip: 60622
Mailing Zip4: Not reported
Mailing Country: USA
Mailing Phone: 312-266-8181

Document ID: NYB7571214
Manifest Status: Completed copy
Trans1 State ID: INZ27741
Trans2 State ID: Not reported
Generator Ship Date: 960403
Trans1 Recv Date: 960403
Trans2 Recv Date: Not reported
TSD Site Recv Date: 960408
Part A Recv Date: Not reported
Part B Recv Date: 960422
Generator EPA ID: ILR000017780
Trans1 EPA ID: IND984874602

CENTERMARK GRAPHICS (Continued) **1001087052**

Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00060
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	004
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100
Year:	96

Document ID:	NYB7278678
Manifest Status:	Completed after the designated time period for a TSDF to get a copy to the DEC
Trans1 State ID:	INPO7663
Trans2 State ID:	Not reported
Generator Ship Date:	960918
Trans1 Recv Date:	960918
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	960923
Part A Recv Date:	961024
Part B Recv Date:	961016
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00045
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	003
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100
Year:	96

Document ID:	NYB8339175
Manifest Status:	Completed after the designated time period for a TSDF to get a copy to the DEC
Trans1 State ID:	IN528162
Trans2 State ID:	Not reported
Generator Ship Date:	961120
Trans1 Recv Date:	961120
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	961125
Part A Recv Date:	970115
Part B Recv Date:	961224
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00075
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	005
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100

CENTERMARK GRAPHICS (Continued) **1001087052**

Year: 96

Document ID: NYG0018711
Manifest Status: Completed copy
Trans1 State ID: IN528162
Trans2 State ID: Not reported
Generator Ship Date: 970528
Trans1 Recv Date: 970528
Trans2 Recv Date: Not reported
TSD Site Recv Date: 970602
Part A Recv Date: 970623
Part B Recv Date: 970611
Generator EPA ID: ILR000017780
Trans1 EPA ID: IND984874602
Trans2 EPA ID: Not reported
TSDF ID: NYD045604964
Waste Code: D011 - SILVER 5.0 MG/L TCLP
Quantity: 00045
Units: G - Gallons (liquids only)* (8.3 pounds)
Number of Containers: 003
Container Type: DF - Fiberboard or plastic drums (glass)
Handling Method: R Material recovery of more than 75 percent of the total material.
Specific Gravity: 100
Year: 97

Document ID: NYB8338149
Manifest Status: Completed copy
Trans1 State ID: INPO7663
Trans2 State ID: Not reported
Generator Ship Date: 961011
Trans1 Recv Date: 961011
Trans2 Recv Date: Not reported
TSD Site Recv Date: 961014
Part A Recv Date: 961024
Part B Recv Date: 961031
Generator EPA ID: ILR000017780
Trans1 EPA ID: IND984874602
Trans2 EPA ID: Not reported
TSDF ID: NYD045604964
Waste Code: D011 - SILVER 5.0 MG/L TCLP
Quantity: 00105
Units: G - Gallons (liquids only)* (8.3 pounds)
Number of Containers: 007
Container Type: DF - Fiberboard or plastic drums (glass)
Handling Method: R Material recovery of more than 75 percent of the total material.
Specific Gravity: 100
Year: 96

Document ID: NYB7277139
Manifest Status: Completed copy
Trans1 State ID: INP07663
Trans2 State ID: Not reported
Generator Ship Date: 960619
Trans1 Recv Date: 960619

CENTERMARK GRAPHICS (Continued) **1001087052**

Trans2 Recv Date:	Not reported
TSD Site Recv Date:	960624
Part A Recv Date:	960716
Part B Recv Date:	960705
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00060
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	004
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100
Year:	96

Document ID:	NYG0019188
Manifest Status:	Completed copy
Trans1 State ID:	IN528162
Trans2 State ID:	Not reported
Generator Ship Date:	970709
Trans1 Recv Date:	970709
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	970714
Part A Recv Date:	Not reported
Part B Recv Date:	970731
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00075
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	005
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100
Year:	97

Document ID:	NYG0018936
Manifest Status:	Completed copy
Trans1 State ID:	IN528162
Trans2 State ID:	Not reported
Generator Ship Date:	970611
Trans1 Recv Date:	970611
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	970616
Part A Recv Date:	970623
Part B Recv Date:	970701
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP

CENTERMARK GRAPHICS (Continued) **1001087052**

Quantity: 00090
Units: G - Gallons (liquids only)* (8.3 pounds)
Number of Containers: 006
Container Type: DF - Fiberboard or plastic drums (glass)
Handling Method: R Material recovery of more than 75 percent of the total material.
Specific Gravity: 100
Year: 97

Document ID: NYB8341884
Manifest Status: Completed copy
Trans1 State ID: IN528162
Trans2 State ID: Not reported
Generator Ship Date: 970312
Trans1 Recv Date: 970312
Trans2 Recv Date: Not reported
TSD Site Recv Date: 970317
Part A Recv Date: 970428
Part B Recv Date: 970331
Generator EPA ID: ILR000017780
Trans1 EPA ID: IND984874602
Trans2 EPA ID: Not reported
TSDF ID: NYD045604964
Waste Code: D011 - SILVER 5.0 MG/L TCLP
Quantity: 00085
Units: G - Gallons (liquids only)* (8.3 pounds)
Number of Containers: 007
Container Type: DF - Fiberboard or plastic drums (glass)
Handling Method: R Material recovery of more than 75 percent of the total material.
Specific Gravity: 100
Year: 97

Document ID: NYG0020196
Manifest Status: Completed copy
Trans1 State ID: IN528162
Trans2 State ID: Not reported
Generator Ship Date: 970827
Trans1 Recv Date: 970827
Trans2 Recv Date: Not reported
TSD Site Recv Date: 970902
Part A Recv Date: 970917
Part B Recv Date: 970919
Generator EPA ID: ILR000017780
Trans1 EPA ID: IND984874602
Trans2 EPA ID: Not reported
TSDF ID: NYD045604964
Waste Code: D011 - SILVER 5.0 MG/L TCLP
Quantity: 00090
Units: G - Gallons (liquids only)* (8.3 pounds)
Number of Containers: 006
Container Type: DF - Fiberboard or plastic drums (glass)
Handling Method: R Material recovery of more than 75 percent of the total material.
Specific Gravity: 100
Year: 97

CENTERMARK GRAPHICS (Continued) **1001087052**

Document ID:	NYB7571673
Manifest Status:	Completed copy
Trans1 State ID:	INZ27741
Trans2 State ID:	Not reported
Generator Ship Date:	960417
Trans1 Recv Date:	960417
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	960422
Part A Recv Date:	960529
Part B Recv Date:	960502
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00030
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	002
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100
Year:	96

Document ID:	NYB7572015
Manifest Status:	Completed copy
Trans1 State ID:	INZ27741
Trans2 State ID:	Not reported
Generator Ship Date:	960501
Trans1 Recv Date:	960501
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	960506
Part A Recv Date:	960510
Part B Recv Date:	960520
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00045
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	003
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100
Year:	96

Document ID:	NYB7276626
Manifest Status:	Completed copy
Trans1 State ID:	INZ27741
Trans2 State ID:	Not reported
Generator Ship Date:	960529
Trans1 Recv Date:	960529
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	960603
Part A Recv Date:	960716

CENTERMARK GRAPHICS (Continued) **1001087052**

Part B Recv Date:	960618
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00015
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	001
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100
Year:	96

Document ID:	NYG0019206
Manifest Status:	Completed after the designated time period for a TSDF to get a copy to the DEC
Trans1 State ID:	IN528162
Trans2 State ID:	Not reported
Generator Ship Date:	970625
Trans1 Recv Date:	970625
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	970630
Part A Recv Date:	970917
Part B Recv Date:	970723
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00045
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	003
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100
Year:	97

Document ID:	NYG0018387
Manifest Status:	Completed copy
Trans1 State ID:	IN528162
Trans2 State ID:	Not reported
Generator Ship Date:	970430
Trans1 Recv Date:	970430
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	970505
Part A Recv Date:	970623
Part B Recv Date:	970515
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00075
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	005

CENTERMARK GRAPHICS (Continued) **1001087052**

Container Type: DF - Fiberboard or plastic drums (glass)
Handling Method: R Material recovery of more than 75 percent of the total material.
Specific Gravity: 100
Year: 97

Document ID: NYB7277625
Manifest Status: Completed copy
Trans1 State ID: INP07663
Trans2 State ID: Not reported
Generator Ship Date: 960710
Trans1 Recv Date: 960710
Trans2 Recv Date: Not reported
TSD Site Recv Date: 960715
Part A Recv Date: 960910
Part B Recv Date: 960801
Generator EPA ID: ILR000017780
Trans1 EPA ID: IND984874602
Trans2 EPA ID: Not reported
TSDF ID: NYD045604964
Waste Code: D011 - SILVER 5.0 MG/L TCLP
Quantity: 00015
Units: G - Gallons (liquids only)* (8.3 pounds)
Number of Containers: 001
Container Type: DF - Fiberboard or plastic drums (glass)
Handling Method: R Material recovery of more than 75 percent of the total material.
Specific Gravity: 100
Year: 96

Document ID: NYB8338572
Manifest Status: Completed copy
Trans1 State ID: IN528162
Trans2 State ID: Not reported
Generator Ship Date: 961023
Trans1 Recv Date: 961023
Trans2 Recv Date: Not reported
TSD Site Recv Date: 961028
Part A Recv Date: 961120
Part B Recv Date: 961115
Generator EPA ID: ILR000017780
Trans1 EPA ID: IND984874602
Trans2 EPA ID: Not reported
TSDF ID: NYD045604964
Waste Code: D011 - SILVER 5.0 MG/L TCLP
Quantity: 00060
Units: G - Gallons (liquids only)* (8.3 pounds)
Number of Containers: 004
Container Type: DF - Fiberboard or plastic drums (glass)
Handling Method: R Material recovery of more than 75 percent of the total material.
Specific Gravity: 100
Year: 96

Document ID: NYB7278084
Manifest Status: Completed copy
Trans1 State ID: INP07663

CENTERMARK GRAPHICS (Continued) **1001087052**

Trans2 State ID:	Not reported
Generator Ship Date:	960731
Trans1 Recv Date:	960731
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	960805
Part A Recv Date:	960910
Part B Recv Date:	960822
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00075
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	005
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100
Year:	96

Document ID:	NYG0017946
Manifest Status:	Completed copy
Trans1 State ID:	IN528162
Trans2 State ID:	Not reported
Generator Ship Date:	970514
Trans1 Recv Date:	970514
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	970519
Part A Recv Date:	970623
Part B Recv Date:	970527
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602
Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00075
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	005
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100
Year:	97

Document ID:	NYB8340264
Manifest Status:	Completed copy
Trans1 State ID:	IN528162
Trans2 State ID:	Not reported
Generator Ship Date:	970108
Trans1 Recv Date:	970108
Trans2 Recv Date:	Not reported
TSD Site Recv Date:	970113
Part A Recv Date:	970212
Part B Recv Date:	970129
Generator EPA ID:	ILR000017780
Trans1 EPA ID:	IND984874602

CENTERMARK GRAPHICS (Continued) **1001087052**

Trans2 EPA ID:	Not reported
TSDF ID:	NYD045604964
Waste Code:	D011 - SILVER 5.0 MG/L TCLP
Quantity:	00090
Units:	G - Gallons (liquids only)* (8.3 pounds)
Number of Containers:	006
Container Type:	DF - Fiberboard or plastic drums (glass)
Handling Method:	R Material recovery of more than 75 percent of the total material.
Specific Gravity:	100
Year:	97

Click this hyperlink while viewing on your computer to access
11 additional NY_MANIFEST: record(s) in the EDR Site Report.

G35 **OLD TOWN VILLAGE WEST** **ENG CONTROLS** **S105424201**
ENE **1198 NORTH HOWE STREET** **INST CONTROL** **N/A**
< 1/8 **CHICAGO, IL 60610** **SRP**
0.095 mi.
502 ft. **Site 2 of 2 in cluster G**

Relative:
Higher

Actual:
587 ft.

ENGINEERING CONTROLS:

Illinois Epa Id:	0316085389
NFR Letter:	07/18/2003
Date NFR Recorded:	09/18/2003
Type Of Site:	Residential
Comprehensive / Focused:	Comprehensive
Remediation Applicant Title:	Mr.
Remediation Applicant Name:	Rob Eshoo
RA Company:	MCL Companies
RA Address:	455 East Illinois Street
RA Secondary Address:	Suite 565
RA City,St,Zip:	Chicago, IL 60611-
Institutional Controls:	Groundwater use restriction
Engineered Barriers:	Asphalt barrier/Clay cap barrier/Concrete barrier/Building foundation
Worker Caution:	True
Acres:	0.252

Illinois Epa Id:	0316085389
NFR Letter:	11/12/2003
Date NFR Recorded:	11/21/2003
Type Of Site:	Residential
Comprehensive / Focused:	Comprehensive
Remediation Applicant Title:	Mr.
Remediation Applicant Name:	Rob Eshoo
RA Company:	MCL Companies
RA Address:	455 East Illinois Street
RA Secondary Address:	Suite 565
RA City,St,Zip:	Chicago, IL 60611-
Institutional Controls:	Groundwater use restriction
Engineered Barriers:	Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution:	True
Acres:	1.129

Illinois Epa Id:	0316085389
NFR Letter:	02/04/2004
Date NFR Recorded:	02/06/2004
Type Of Site:	Residential
Comprehensive / Focused:	Comprehensive

OLD TOWN VILLAGE WEST (Continued) **S105424201**

Remediation Applicant Title: Mr.
Remediation Applicant Name: Rob Eshoo
RA Company: MCL Companies
RA Address: 455 East Illinois Street
RA Secondary Address: Suite 565
RA City,St,Zip: Chicago, IL 60611-
Institutional Controls: Groundwater use restriction
Engineered Barriers: Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution: True
Acres: 1.070

Illinois Epa Id: 0316085389
NFR Letter: 01/25/2005
Date NFR Recorded: 01/31/2005
Type Of Site: Residential
Comprehensive / Focused: Comprehensive
Remediation Applicant Title: Mr.
Remediation Applicant Name: Rob Eshoo
RA Company: MCL Companies
RA Address: 455 East Illinois Street
RA Secondary Address: Suite 565
RA City,St,Zip: Chicago, IL 60611-
Institutional Controls: Groundwater use restriction
Engineered Barriers: Asphalt barrier/Clean soil barrier/Concrete cap barrier/Building foundation
Worker Caution: True
Acres: 0.680

Illinois Epa Id: 0316085389
NFR Letter: 06/15/2005
Date NFR Recorded: 06/17/2005
Type Of Site: Residential
Comprehensive / Focused: Comprehensive
Remediation Applicant Title: Mr.
Remediation Applicant Name: Rob Eshoo
RA Company: MCL Companies
RA Address: 455 East Illinois Street
RA Secondary Address: Suite 565
RA City,St,Zip: Chicago, IL 60611-
Institutional Controls: Groundwater use restriction
Engineered Barriers: Asphalt barrier/Clean soil barrier/Concrete barrier/Building foundation
Worker Caution: True
Acres: 0.949

IL INSTUTIONAL CONTROL:
Illinois EPA Id: 0316085389
NFR Letter: 07/18/2003
Date NFR Recorded: 09/18/2003
Type Of Site: Residential
Comprehensive / Focused: Comprehensive
Remediation Applicant Title: Mr.
Remediation Applicant Name: Rob Eshoo
RA Company: MCL Companies
RA Address: 455 East Illinois Street
RA Secondary Address: Suite 565
RA City,St,Zip: Chicago, IL 60611-
Institutional Controls: Groundwater use restriction
Engineered Barriers: Asphalt barrier/Clay cap barrier/Concrete barrier/Building foundation

OLD TOWN VILLAGE WEST (Continued) **S105424201**

Worker Caution:	True
Acres:	0.252
Illinois EPA Id:	0316085389
NFR Letter:	11/12/2003
Date NFR Recorded:	11/21/2003
Type Of Site:	Residential
Comprehensive / Focused:	Comprehensive
Remediation Applicant Title:	Mr.
Remediation Applicant Name:	Rob Eshoo
RA Company:	MCL Companies
RA Address:	455 East Illinois Street
RA Secondary Address:	Suite 565
RA City,St,Zip:	Chicago, IL 60611-
Institutional Controls:	Groundwater use restriction
Engineered Barriers:	Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution:	True
Acres:	1.129
Illinois EPA Id:	0316085389
NFR Letter:	02/04/2004
Date NFR Recorded:	02/06/2004
Type Of Site:	Residential
Comprehensive / Focused:	Comprehensive
Remediation Applicant Title:	Mr.
Remediation Applicant Name:	Rob Eshoo
RA Company:	MCL Companies
RA Address:	455 East Illinois Street
RA Secondary Address:	Suite 565
RA City,St,Zip:	Chicago, IL 60611-
Institutional Controls:	Groundwater use restriction
Engineered Barriers:	Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution:	True
Acres:	1.070
Illinois EPA Id:	0316085389
NFR Letter:	01/25/2005
Date NFR Recorded:	01/31/2005
Type Of Site:	Residential
Comprehensive / Focused:	Comprehensive
Remediation Applicant Title:	Mr.
Remediation Applicant Name:	Rob Eshoo
RA Company:	MCL Companies
RA Address:	455 East Illinois Street
RA Secondary Address:	Suite 565
RA City,St,Zip:	Chicago, IL 60611-
Institutional Controls:	Groundwater use restriction
Engineered Barriers:	Asphalt barrier/Clean soil barrier/Concrete cap barrier/Building foundation
Worker Caution:	True
Acres:	0.680
Illinois EPA Id:	0316085389
NFR Letter:	06/15/2005
Date NFR Recorded:	06/17/2005
Type Of Site:	Residential
Comprehensive / Focused:	Comprehensive
Remediation Applicant Title:	Mr.

OLD TOWN VILLAGE WEST (Continued) **S105424201**

Remediation Applicant Name: Rob Eshoo
RA Company: MCL Companies
RA Address: 455 East Illinois Street
RA Secondary Address: Suite 565
RA City,St,Zip: Chicago, IL 60611-
Institutional Controls: Groundwater use restriction
Engineered Barriers: Asphalt barrier/Clean soil barrier/Concrete barrier/Building foundation
Worker Caution: True
Acres: 0.949

SRP:
IL EPA Id: 0316085389
US EPA Id: Not reported
Longitude: -87.645709999999994
Latitude: 41.903449999999999
Contact Name: Rob Eshoo
Contact Address: 455 East Illinois Street
Contact Address2: Suite 565
Contact City,St,Zip: Chicago, IL 60611-
Contact Phone: (312) 321-8900
Date Enrolled: 05/03/2002
Point Of Contact: Jeffrey McClelland, P.E.
Consultant Company: Pioneer Engineering & Environmental Services, Inc.
Consultant Address: 700 North Sacramento Boulevard
Consultant Address2: Suite 101
Consultant City,St,Zip: Chicago, IL 60612-
Consultant Phone: (312) 587-1021
Proj Mgr Assigned: Hall
Sec. 4 Letter Date: Not reported
NFR Recorded: 2005-06-17
Active: False
Total Acres: 1.070
No Further Remediation Letter Dt: 2005-06-15
Remediation Applicant Co: MCL Companies
Remediation Applicant Title: Mr.
Remediation Applicant Name: Mr. Rob Eshoo
Remediation Applicant Company: MCL Companies
Remediation Applicant Address: 455 East Illinois Street
Remediation Applicant Address 2: Suite 565
Remediation Applicant City,St,Zip: Chicago, IL 60611-
Illinois EPA: 0316085389
Site Name: Old Town Village West
NFR Letter: 2003-07-18 00:00:00
NFR Letter Date Recorded: 2003-09-18 00:00:00
Site Type: Residential
Comprehensive/Focused: Comprehensive
Institutional Controls: Groundwater use restriction
Barrier: Asphalt barrier/Clay cap barrier/Concrete barrier/Building foundation
Worker Caution: True
Acres: 0.252

Remediation Applicant Name: Mr. Rob Eshoo
Remediation Applicant Company: MCL Companies
Remediation Applicant Address: 455 East Illinois Street
Remediation Applicant Address 2: Suite 565
Remediation Applicant City,St,Zip: Chicago, IL 60611-
Illinois EPA: 0316085389

OLD TOWN VILLAGE WEST (Continued) **S105424201**

Site Name:	Old Town Village West
NFR Letter:	2003-11-12 00:00:00
NFR Letter Date Recorded:	2003-11-21 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution:	True
Acres:	1.129
Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2004-02-04 00:00:00
NFR Letter Date Recorded:	2004-02-06 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution:	True
Acres:	1.070
Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2005-01-25 00:00:00
NFR Letter Date Recorded:	2005-01-31 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Clean soil barrier/Concrete cap barrier/Building foundation
Worker Caution:	True
Acres:	0.680
Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2005-06-15 00:00:00
NFR Letter Date Recorded:	2005-06-17 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Clean soil barrier/Concrete barrier/Building foundation
Worker Caution:	True
Acres:	0.949

OLD TOWN VILLAGE WEST (Continued) **S105424201**

IL EPA Id:	0316085389
US EPA Id:	Not reported
Longitude:	-87.645709999999994
Latitude:	41.903449999999999
Contact Name:	Rob Eshoo
Contact Address:	455 East Illinois Street
Contact Address2:	Suite 565
Contact City,St,Zip:	Chicago, IL 60611-
Contact Phone:	(312) 321-8900
Date Enrolled:	05/03/2002
Point Of Contact:	Jeffrey McClelland, P.E.
Consultant Company:	Pioneer Engineering & Environmental Services, Inc.
Consultant Address:	700 North Sacramento Boulevard
Consultant Address2:	Suite 101
Consultant City,St,Zip:	Chicago, IL 60612-
Consultant Phone:	(312) 587-1021
Proj Mgr Assigned:	Hall
Sec. 4 Letter Date:	Not reported
NFR Recorded:	2005-01-31
Active:	False
Total Acres:	1.070
No Further Remediation Letter Dt:	2005-01-25
Remediation Applicant Co:	MCL Companies
Remediation Applicant Title:	Mr.
Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2003-07-18 00:00:00
NFR Letter Date Recorded:	2003-09-18 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Clay cap barrier/Concrete barrier/Building foundation
Worker Caution:	True
Acres:	0.252
Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2003-11-12 00:00:00
NFR Letter Date Recorded:	2003-11-21 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution:	True
Acres:	1.129
Remediation Applicant Name:	Mr. Rob Eshoo

OLD TOWN VILLAGE WEST (Continued) **S105424201**

Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2004-02-04 00:00:00
NFR Letter Date Recorded:	2004-02-06 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution:	True
Acres:	1.070

Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2005-01-25 00:00:00
NFR Letter Date Recorded:	2005-01-31 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Clean soil barrier/Concrete cap barrier/Building foundation
Worker Caution:	True
Acres:	0.680

Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2005-06-15 00:00:00
NFR Letter Date Recorded:	2005-06-17 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Clean soil barrier/Concrete barrier/Building foundation
Worker Caution:	True
Acres:	0.949

IL EPA Id:	0316085389
US EPA Id:	Not reported
Longitude:	-87.645709999999994
Latitude:	41.903449999999999
Contact Name:	Rob Eshoo
Contact Address:	455 East Illinois Street
Contact Address2:	Suite 565
Contact City,St,Zip:	Chicago, IL 60611-
Contact Phone:	(312) 321-8900

OLD TOWN VILLAGE WEST (Continued) **S105424201**

Date Enrolled:	05/03/2002
Point Of Contact:	Jeffrey McClelland, P.E.
Consultant Company:	Pioneer Engineering & Environmental Services, Inc.
Consultant Address:	700 North Sacramento Boulevard
Consultant Address2:	Suite 101
Consultant City,St,Zip:	Chicago, IL 60612-
Consultant Phone:	(312) 587-1021
Proj Mgr Assigned:	Hall
Sec. 4 Letter Date:	Not reported
NFR Recorded:	2004-02-06
Active:	False
Total Acres:	1.070
No Further Remediation Letter Dt:	2004-02-04
Remediation Applicant Co:	MCL Companies
Remediation Applicant Title:	Mr.
Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2003-07-18 00:00:00
NFR Letter Date Recorded:	2003-09-18 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Clay cap barrier/Concrete barrier/Building foundation
Worker Caution:	True
Acres:	0.252

Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2003-11-12 00:00:00
NFR Letter Date Recorded:	2003-11-21 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution:	True
Acres:	1.129

Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2004-02-04 00:00:00
NFR Letter Date Recorded:	2004-02-06 00:00:00
Site Type:	Residential

OLD TOWN VILLAGE WEST (Continued) **S105424201**

Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution:	True
Acres:	1.070

Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2005-01-25 00:00:00
NFR Letter Date Recorded:	2005-01-31 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Clean soil barrier/Concrete cap barrier/Building foundation
Worker Caution:	True
Acres:	0.680

Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2005-06-15 00:00:00
NFR Letter Date Recorded:	2005-06-17 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Clean soil barrier/Concrete barrier/Building foundation
Worker Caution:	True
Acres:	0.949

IL EPA Id:	0316085389
US EPA Id:	Not reported
Longitude:	-87.645709999999994
Latitude:	41.903449999999999
Contact Name:	Rob Eshoo
Contact Address:	455 East Illinois Street
Contact Address2:	Suite 565
Contact City,St,Zip:	Chicago, IL 60611-
Contact Phone:	(312) 321-8900
Date Enrolled:	05/03/2002
Point Of Contact:	Jeffrey McClelland, P.E.
Consultant Company:	Pioneer Engineering & Environmental Services, Inc.
Consultant Address:	700 North Sacramento Boulevard
Consultant Address2:	Suite 101
Consultant City,St,Zip:	Chicago, IL 60612-
Consultant Phone:	(312) 587-1021
Proj Mgr Assigned:	Hall
Sec. 4 Letter Date:	Not reported

OLD TOWN VILLAGE WEST (Continued) **S105424201**

NFR Recorded: 2003-09-18
Active: False
Total Acres: 1.070
No Further Remediation Letter Dt: 2003-07-18
Remediation Applicant Co: MCL Companies
Remediation Applicant Title: Mr.
Remediation Applicant Name: Mr. Rob Eshoo
Remediation Applicant Company: MCL Companies
Remediation Applicant Address: 455 East Illinois Street
Remediation Applicant Address 2: Suite 565
Remediation Applicant City,St,Zip: Chicago, IL 60611-
Illinois EPA: 0316085389
Site Name: Old Town Village West
NFR Letter: 2003-07-18 00:00:00
NFR Letter Date Recorded: 2003-09-18 00:00:00
Site Type: Residential
Comprehensive/Focused: Comprehensive
Institutional Controls: Groundwater use restriction
Barrier: Asphalt barrier/Clay cap barrier/Concrete barrier/Building foundation
Worker Caution: True
Acres: 0.252

Remediation Applicant Name: Mr. Rob Eshoo
Remediation Applicant Company: MCL Companies
Remediation Applicant Address: 455 East Illinois Street
Remediation Applicant Address 2: Suite 565
Remediation Applicant City,St,Zip: Chicago, IL 60611-
Illinois EPA: 0316085389
Site Name: Old Town Village West
NFR Letter: 2003-11-12 00:00:00
NFR Letter Date Recorded: 2003-11-21 00:00:00
Site Type: Residential
Comprehensive/Focused: Comprehensive
Institutional Controls: Groundwater use restriction
Barrier: Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution: True
Acres: 1.129

Remediation Applicant Name: Mr. Rob Eshoo
Remediation Applicant Company: MCL Companies
Remediation Applicant Address: 455 East Illinois Street
Remediation Applicant Address 2: Suite 565
Remediation Applicant City,St,Zip: Chicago, IL 60611-
Illinois EPA: 0316085389
Site Name: Old Town Village West
NFR Letter: 2004-02-04 00:00:00
NFR Letter Date Recorded: 2004-02-06 00:00:00
Site Type: Residential
Comprehensive/Focused: Comprehensive
Institutional Controls: Groundwater use restriction
Barrier: Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution: True
Acres: 1.070

Remediation Applicant Name: Mr. Rob Eshoo
Remediation Applicant Company: MCL Companies
Remediation Applicant Address: 455 East Illinois Street

OLD TOWN VILLAGE WEST (Continued) **S105424201**

Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2005-01-25 00:00:00
NFR Letter Date Recorded:	2005-01-31 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Clean soil barrier/Concrete cap barrier/Building foundation
Worker Caution:	True
Acres:	0.680

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Site Name:	Old Town Village West
NFR Letter:	2005-06-15 00:00:00
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Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Clean soil barrier/Concrete barrier/Building foundation
Worker Caution:	True
Acres:	0.949

IL EPA Id:	0316085389
US EPA Id:	Not reported
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Latitude:	41.903449999999999
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Contact Phone:	(312) 321-8900
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Consultant City,St,Zip:	Chicago, IL 60612-
Consultant Phone:	(312) 587-1021
Proj Mgr Assigned:	Hall
Sec. 4 Letter Date:	Not reported
NFR Recorded:	2003-11-21
Active:	False
Total Acres:	1.070
No Further Remediation Letter Dt:	2003-11-12
Remediation Applicant Co:	MCL Companies
Remediation Applicant Title:	Mr.
Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street

OLD TOWN VILLAGE WEST (Continued) **S105424201**

Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2003-07-18 00:00:00
NFR Letter Date Recorded:	2003-09-18 00:00:00
Site Type:	Residential
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Remediation Applicant Name:	Mr. Rob Eshoo
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Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2004-02-04 00:00:00
NFR Letter Date Recorded:	2004-02-06 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Concrete barrier/Clean soil barrier/Building foundation
Worker Caution:	True
Acres:	1.070

Remediation Applicant Name:	Mr. Rob Eshoo
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Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
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NFR Letter:	2005-01-25 00:00:00
NFR Letter Date Recorded:	2005-01-31 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction

OLD TOWN VILLAGE WEST (Continued) **S105424201**

Barrier:	Asphalt barrier/Clean soil barrier/Concrete cap barrier/Building foundation
Worker Caution:	True
Acres:	0.680
Remediation Applicant Name:	Mr. Rob Eshoo
Remediation Applicant Company:	MCL Companies
Remediation Applicant Address:	455 East Illinois Street
Remediation Applicant Address 2:	Suite 565
Remediation Applicant City,St,Zip:	Chicago, IL 60611-
Illinois EPA:	0316085389
Site Name:	Old Town Village West
NFR Letter:	2005-06-15 00:00:00
NFR Letter Date Recorded:	2005-06-17 00:00:00
Site Type:	Residential
Comprehensive/Focused:	Comprehensive
Institutional Controls:	Groundwater use restriction
Barrier:	Asphalt barrier/Clean soil barrier/Concrete barrier/Building foundation
Worker Caution:	True
Acres:	0.949

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36 **OGDEN AV LAUNDRY** **EDR Historical Cleaners** **1009198592**
North **1217 BURLING** **N/A**
< 1/8 **CHICAGO, IL**
0.096 mi.
506 ft.

Relative: **Higher**

Actual: **590 ft.**

EDR Historical Cleaners:

Name:	OGDEN AV LAUNDRY
Year:	1928
Type:	LAUNDRIES STEAM

H37 **GREYHOUND LINES INC** **RCRA-SQG** **1000441470**
SW **901 N HALSTED** **FINDS** **ILD077005064**
< 1/8 **CHICAGO, IL 60610** **NPDES**
0.103 mi. **LUST**
543 ft. **Site 1 of 5 in cluster H**

Relative: **Lower**

Actual: **583 ft.**

RCRA-SQG:

Date form received by agency:	11/17/2009
Facility name:	GREYHOUND LINES INC 560018
Facility address:	901 N HALSTED CHICAGO, IL 60622
EPA ID:	ILD077005064
Mailing address:	110 PERIMETER PARK STE E KNOXVILLE, TN 37922
Contact:	RICHARD BUSH
Contact address:	Not reported Not reported
Contact country:	Not reported
Contact telephone:	(312) 408-5955
Contact email:	RICHARD.BUSH@GREYHOUND.COM
EPA Region:	05
Land type:	Private
Classification:	Small Small Quantity Generator
Description:	Handler: generates more than 100 and less than 1000 kg of hazardous

GREYHOUND LINES INC (Continued) **1000441470**

waste during any calendar month and accumulates less than 6000 kg of hazardous waste at any time; or generates 100 kg or less of hazardous waste during any calendar month, and accumulates more than 1000 kg of hazardous waste at any time

Owner/Operator Summary:

Owner/operator name:	GREYHOUND LINES INC
Owner/operator address:	600 VINE ST STE 1400 CINCINNATI, OH 45202
Owner/operator country:	US
Owner/operator telephone:	Not reported
Legal status:	Private
Owner/Operator Type:	Operator
Owner/Op start date:	06/04/1984
Owner/Op end date:	Not reported

Owner/operator name:	GREYHOUND LINES INC
Owner/operator address:	600 VINE ST STE 1400 CINCINNATI, OH 45202
Owner/operator country:	US
Owner/operator telephone:	Not reported
Legal status:	Private
Owner/Operator Type:	Owner
Owner/Op start date:	06/04/1984
Owner/Op end date:	Not reported

Handler Activities Summary:

U.S. importer of hazardous waste:	No
Mixed waste (haz. and radioactive):	No
Recycler of hazardous waste:	No
Transporter of hazardous waste:	No
Treater, storer or disposer of HW:	No
Underground injection activity:	No
On-site burner exemption:	No
Furnace exemption:	No
Used oil fuel burner:	No
Used oil processor:	No
User oil refiner:	No
Used oil fuel marketer to burner:	No
Used oil Specification marketer:	No
Used oil transfer facility:	No
Used oil transporter:	No

Historical Generators:

Date form received by agency:	10/22/1999
Facility name:	GREYHOUND LINES INC 560018
Site name:	GREYHOUND LINES, INC
Classification:	Small Quantity Generator

Date form received by agency:	02/28/1990
Facility name:	GREYHOUND LINES INC 560018
Site name:	GREYHOUND BUS LINES
Classification:	Large Quantity Generator

Hazardous Waste Summary:

GREYHOUND LINES INC (Continued) **1000441470**

Waste code: D001
Waste name: IGNITABLE HAZARDOUS WASTES ARE THOSE WASTES WHICH HAVE A FLASHPOINT OF LESS THAN 140 DEGREES FAHRENHEIT AS DETERMINED BY A PENSKY-MARTENS CLOSED CUP FLASH POINT TESTER. ANOTHER METHOD OF DETERMINING THE FLASH POINT OF A WASTE IS TO REVIEW THE MATERIAL SAFETY DATA SHEET, WHICH CAN BE OBTAINED FROM THE MANUFACTURER OR DISTRIBUTOR OF THE MATERIAL. LACQUER THINNER IS AN EXAMPLE OF A COMMONLY USED SOLVENT WHICH WOULD BE CONSIDERED AS IGNITABLE HAZARDOUS WASTE.

Waste code: F003
Waste name: THE FOLLOWING SPENT NON-HALOGENATED SOLVENTS: XYLENE, ACETONE, ETHYL ACETATE, ETHYL BENZENE, ETHYL ETHER, METHYL ISOBUTYL KETONE, N-BUTYL ALCOHOL, CYCLOHEXANONE, AND METHANOL; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, ONLY THE ABOVE SPENT NON-HALOGENATED SOLVENTS; AND ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, ONE OR MORE OF THE ABOVE NON-HALOGENATED SOLVENTS, AND, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THOSE SOLVENTS LISTED IN F001, F002, F004, AND F005, AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.

Waste code: F005
Waste name: THE FOLLOWING SPENT NON-HALOGENATED SOLVENTS: TOLUENE, METHYL ETHYL KETONE, CARBON DISULFIDE, ISOBUTANOL, PYRIDINE, BENZENE, 2-ETHOXYETHANOL, AND 2-NITROPROPANE; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THE ABOVE NON-HALOGENATED SOLVENTS OR THOSE SOLVENTS LISTED IN F001, F002, OR F004; AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.

Violation Status: No violations found

Evaluation Action Summary:
Evaluation date: 03/20/1992
Evaluation: COMPLIANCE EVALUATION INSPECTION ON-SITE
Area of violation: Not reported
Date achieved compliance: Not reported
Evaluation lead agency: State

FINDS:

Registry ID: 110005839726

Environmental Interest/Information System

ACES (Illinois - Agency Compliance And Enforcement System) is the Illinois EPA Project to facilitate the permitting operations

US National Pollutant Discharge Elimination System (NPDES) module of the Compliance Information System (ICIS) tracks surface water permits issued under the Clean Water Act. Under NPDES, all facilities that discharge pollutants from any point source into waters of the United States are required to obtain a permit. The permit will likely contain limits on what can be discharged, impose monitoring and reporting requirements, and include other provisions to ensure that the discharge does not adversely affect water quality.

RCRAInfo is a national information system that supports the Resource

GREYHOUND LINES INC (Continued) **1000441470**

Conservation and Recovery Act (RCRA) program through the tracking of events and activities related to facilities that generate, transport, and treat, store, or dispose of hazardous waste. RCRAInfo allows RCRA program staff to track the notification, permit, compliance, and corrective action activities required under RCRA.

PCS (Permit Compliance System) is a computerized management information system that contains data on National Pollutant Discharge Elimination System (NPDES) permit holding facilities. PCS tracks the permit, compliance, and enforcement status of NPDES facilities.

NPDES:

Permit Id No:	ILR004340
Date Permit Issued:	5/1/2009
Type Of Permit:	Privately Owned Facility
Latitude:	+ 41 53' 57" 0
Longitude:	- 87 38' 52" 4
Facility Receiving Water:	Not reported
Effective Date:	5/1/2009
Expiration Date:	4/30/2014

LUST:

Incident Num:	920447
IL EPA Id:	0316005047
Product:	Unleaded Gas, Deisel, Uset Oil, Non Petro
IEMA Date:	02/18/1992
Project Manager:	Weller
Project Manager Phone:	(217) 524-4647
Email:	Melinda.Weller@illinois.gov
PRP Name:	Greyhound Lines Inc.
PRP Contact:	Van Hartnitt
PRP Address:	P.O. Box 660362
PRP City,St,Zip:	Dallas, TX 75266-0362
PRP Phone:	Not reported
Site Classification:	Not reported
Section 57.5(g) Letter:	731
Non LUST Determination Letter:	Not reported
20 Report Received:	03/11/1992
45 Report Received:	04/16/1992
Section 57.5(g) Letter:	Not reported
NFA/NFR Letter:	**12/09/1997**
NFR Date Recorded:	02/20/1998

H38 **GREYHOUND LINES, INC.** **UST** **U001142531**
SW **901 N. HALSTED STREET** **N/A**
< 1/8 **CHICAGO, IL 60622**
0.103 mi.
543 ft. **Site 2 of 5 in cluster H**

Relative:
Lower

Actual:
583 ft.

UST:

Facility ID:	2021989
Facility Status:	Active
Facility Type:	**Commercial / Retail**
Owner Name:	Greyhound Lines, Inc.
Owner Id:	U0021756
Owner Address:	c/o Strata Environmental, 110 Perimeter Park, St E

GREYHOUND LINES, INC. (Continued) **U001142531**

Owner City,St,Zip: Knoxville, TN 37922

Tank Number: 1
Tank Capacity: 19000
Tank Substance: Diesel Fuel
Last Used Date: 3/1/1992
OSFM First Notify Date: 5/5/1986
Tank Status: Abandoned in place
Red Tag Issue Date: Not reported
Install Date: 1/1/1967
Green Tag Decal: L003509
Green Tag Issue Date: 6/8/2010
Green Tag Expire Date: 12/31/2012
Self Service Permit Inspection Date: Not reported
Self Service Permit Expire Date: Not reported
Fee Due: No

Tank Number: 10
Tank Capacity: 30000
Tank Substance: Heating Oil
Last Used Date: 3/1/1992
OSFM First Notify Date: 5/5/1986
Tank Status: Abandoned in place
Red Tag Issue Date: Not reported
Install Date: 1/1/1967
Green Tag Decal: L003509
Green Tag Issue Date: 6/8/2010
Green Tag Expire Date: 12/31/2012
Self Service Permit Inspection Date: Not reported
Self Service Permit Expire Date: Not reported
Fee Due: No

Tank Number: 11
Tank Capacity: 15000
Tank Substance: Diesel Fuel
Last Used Date: Not reported
OSFM First Notify Date: 5/8/2000
Tank Status: Currently in use
Red Tag Issue Date: Not reported
Install Date: 6/1/1992
Green Tag Decal: L003509
Green Tag Issue Date: 6/8/2010
Green Tag Expire Date: 12/31/2012
Self Service Permit Inspection Date: Not reported
Self Service Permit Expire Date: Not reported
Fee Due: No

Tank Number: 12
Tank Capacity: 15000
Tank Substance: Diesel Fuel
Last Used Date: Not reported
OSFM First Notify Date: 5/8/2000
Tank Status: Currently in use
Red Tag Issue Date: Not reported

GREYHOUND LINES, INC. (Continued) **U001142531**

Install Date:	6/1/1992
Green Tag Decal:	**L003509**
Green Tag Issue Date:	**6/8/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

Tank Number:	13
Tank Capacity:	6000
Tank Substance:	Motor Oil
Last Used Date:	Not reported
OSFM First Notify Date:	5/8/2000
Tank Status:	**Currently in use**
Red Tag Issue Date:	Not reported
Install Date:	6/1/1992
Green Tag Decal:	**L003509**
Green Tag Issue Date:	**6/8/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

Tank Number:	14
Tank Capacity:	10000
Tank Substance:	Anti-Freeze
Last Used Date:	6/1/1992
OSFM First Notify Date:	5/5/1986
Tank Status:	**Abandoned in place**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1967
Green Tag Decal:	**L003509**
Green Tag Issue Date:	**6/8/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

Tank Number:	2
Tank Capacity:	19000
Tank Substance:	Diesel Fuel
Last Used Date:	3/1/1992
OSFM First Notify Date:	5/5/1986
Tank Status:	**Abandoned in place**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1967
Green Tag Decal:	**L003509**
Green Tag Issue Date:	**6/8/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

GREYHOUND LINES, INC. (Continued) **U001142531**

Tank Number:	3
Tank Capacity:	19000
Tank Substance:	Diesel Fuel
Last Used Date:	3/1/1992
OSFM First Notify Date:	5/5/1986
Tank Status:	**Abandoned in place**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1967
Green Tag Decal:	**L003509**
Green Tag Issue Date:	**6/8/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

Tank Number:	4
Tank Capacity:	19000
Tank Substance:	Diesel Fuel
Last Used Date:	3/1/1992
OSFM First Notify Date:	5/5/1986
Tank Status:	**Abandoned in place**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1967
Green Tag Decal:	**L003509**
Green Tag Issue Date:	**6/8/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

Tank Number:	5
Tank Capacity:	1000
Tank Substance:	Diesel Fuel
Last Used Date:	3/1/1992
OSFM First Notify Date:	5/5/1986
Tank Status:	**Abandoned in place**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1967
Green Tag Decal:	**L003509**
Green Tag Issue Date:	**6/8/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

Tank Number:	6
Tank Capacity:	5000
Tank Substance:	Motor Oil
Last Used Date:	3/1/1992
OSFM First Notify Date:	5/5/1986
Tank Status:	**Abandoned in place**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1967
Green Tag Decal:	**L003509**

GREYHOUND LINES, INC. (Continued) **U001142531**

Green Tag Issue Date:	**6/8/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

Tank Number:	7
Tank Capacity:	1000
Tank Substance:	Used Oil
Last Used Date:	3/1/1992
OSFM First Notify Date:	5/5/1986
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1967
Green Tag Decal:	**L003509**
Green Tag Issue Date:	**6/8/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

Tank Number:	8
Tank Capacity:	1000
Tank Substance:	Used Oil
Last Used Date:	3/1/1992
OSFM First Notify Date:	5/5/1986
Tank Status:	**Abandoned in place**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1967
Green Tag Decal:	**L003509**
Green Tag Issue Date:	**6/8/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

Tank Number:	9
Tank Capacity:	10000
Tank Substance:	Gasoline
Last Used Date:	Not reported
OSFM First Notify Date:	5/5/1986
Tank Status:	**Removed**
Red Tag Issue Date:	Not reported
Install Date:	1/1/1967
Green Tag Decal:	**L003509**
Green Tag Issue Date:	**6/8/2010**
Green Tag Expire Date:	**12/31/2012**
Self Service Permit Inspection Date:	**Not reported**
Self Service Permit Expire Date:	**Not reported**
Fee Due:	No

I39 **GOLD COAST AUTO BODY INC** **RCRA-SQG** **1004697739**
West **900 W DIVISION** **FINDS** **ILR000080580**
< 1/8 **CHICAGO, IL 60622**
0.120 mi.
632 ft. **Site 1 of 4 in cluster I**

Relative:
Lower

Actual:
581 ft.

RCRA-SQG:

Date form received by agency:	08/17/2000
Facility name:	GOLD COAST AUTO BODY INC
Facility address:	900 W DIVISION CHICAGO, IL 60622
EPA ID:	ILR000080580
Contact:	DOMINIC MARTINO
Contact address:	900 W DIVISION CHICAGO, IL 60622
Contact country:	US
Contact telephone:	(312) 787-0333
Contact email:	Not reported
EPA Region:	05
Classification:	Small Small Quantity Generator
Description:	Handler: generates more than 100 and less than 1000 kg of hazardous waste during any calendar month and accumulates less than 6000 kg of hazardous waste at any time; or generates 100 kg or less of hazardous waste during any calendar month, and accumulates more than 1000 kg of hazardous waste at any time

Owner/Operator Summary:

Owner/operator name:	MARTINO LORENZO
Owner/operator address:	900 W DIVISION CHICAGO, IL 60622
Owner/operator country:	Not reported
Owner/operator telephone:	(312) 787-0333
Legal status:	Private
Owner/Operator Type:	Owner
Owner/Op start date:	Not reported
Owner/Op end date:	Not reported

Handler Activities Summary:

U.S. importer of hazardous waste:	No
Mixed waste (haz. and radioactive):	No
Recycler of hazardous waste:	No
Transporter of hazardous waste:	No
Treater, storer or disposer of HW:	No
Underground injection activity:	No
On-site burner exemption:	No
Furnace exemption:	No
Used oil fuel burner:	No
Used oil processor:	No
User oil refiner:	No
Used oil fuel marketer to burner:	No
Used oil Specification marketer:	No
Used oil transfer facility:	No
Used oil transporter:	No

Hazardous Waste Summary:

Waste code:	D001
Waste name:	IGNITABLE HAZARDOUS WASTES ARE THOSE WASTES WHICH HAVE A FLASHPOINT OF LESS THAN 140 DEGREES FAHRENHEIT AS DETERMINED BY A PENSKY-MARTENS

GOLD COAST AUTO BODY INC (Continued) **1004697739**

CLOSED CUP FLASH POINT TESTER. ANOTHER METHOD OF DETERMINING THE FLASH POINT OF A WASTE IS TO REVIEW THE MATERIAL SAFETY DATA SHEET, WHICH CAN BE OBTAINED FROM THE MANUFACTURER OR DISTRIBUTOR OF THE MATERIAL. LACQUER THINNER IS AN EXAMPLE OF A COMMONLY USED SOLVENT WHICH WOULD BE CONSIDERED AS IGNITABLE HAZARDOUS WASTE.

Waste code: D008
Waste name: LEAD

Waste code: F005
Waste name: THE FOLLOWING SPENT NON-HALOGENATED SOLVENTS: TOLUENE, METHYL ETHYL KETONE, CARBON DISULFIDE, ISOBUTANOL, PYRIDINE, BENZENE, 2-ETHOXYETHANOL, AND 2-NITROPROPANE; ALL SPENT SOLVENT MIXTURES/BLENDS CONTAINING, BEFORE USE, A TOTAL OF TEN PERCENT OR MORE (BY VOLUME) OF ONE OR MORE OF THE ABOVE NON-HALOGENATED SOLVENTS OR THOSE SOLVENTS LISTED IN F001, F002, OR F004; AND STILL BOTTOMS FROM THE RECOVERY OF THESE SPENT SOLVENTS AND SPENT SOLVENT MIXTURES.

Violation Status: No violations found

FINDS:

Registry ID: 110003059500

Environmental Interest/Information System

ACES (Illinois - Agency Compliance And Enforcement System) is the Illinois EPA Project to facilitate the permitting operations

RCRAInfo is a national information system that supports the Resource Conservation and Recovery Act (RCRA) program through the tracking of events and activities related to facilities that generate, transport, and treat, store, or dispose of hazardous waste. RCRAInfo allows RCRA program staff to track the notification, permit, compliance, and corrective action activities required under RCRA.

J40 **MW-CPAG HOLDINGS, LLC** **LUST** **S105155412**
SSE **946 NORTH CROSBY STREET** **ENG CONTROLS** **N/A**
1/8-1/4 **CHICAGO, IL 60610** **INST CONTROL**
0.129 mi. **SRP**
683 ft. **Site 1 of 4 in cluster J**

Relative:
Lower

Actual:
582 ft.

LUST:

Incident Num:	20011773
IL EPA Id:	0316085161
Product:	Other Petro
IEMA Date:	10/23/2001
Project Manager:	NOT ASSIGNED
Project Manager Phone:	Not reported
Email:	Not reported
PRP Name:	MW - C.P.A.G. Holdings, LLC
PRP Contact:	Nancy Carreon
PRP Address:	600 West Chicago, 5th Fl.
PRP City,St,Zip:	Chicago, IL 60610
PRP Phone:	3129232327
Site Classification:	Not reported
Section 57.5(g) Letter:	732
Non LUST Determination Letter:	Not reported

APPENDIX A3

EDR HISTORICAL TOPOGRAPHIC MAP REPORT
(INCLUDED ON CD)

North Station
1127 Halsted
Chicago, IL 60610

Inquiry Number: 3066595.4
May 12, 2011

EDR Historical Topographic Map Report

EDR® Environmental Data Resources Inc

440 Wheelers Farms Road
Milford, CT 06461
800.352.0050
www.edrnet.com

EDR Historical Topographic Map Report

Environmental Data Resources, Inc.s (EDR) Historical Topographic Map Report is designed to assist professionals in evaluating potential liability on a target property resulting from past activities. EDRs Historical Topographic Map Report includes a search of a collection of public and private color historical topographic maps, dating back to the early 1900s.

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

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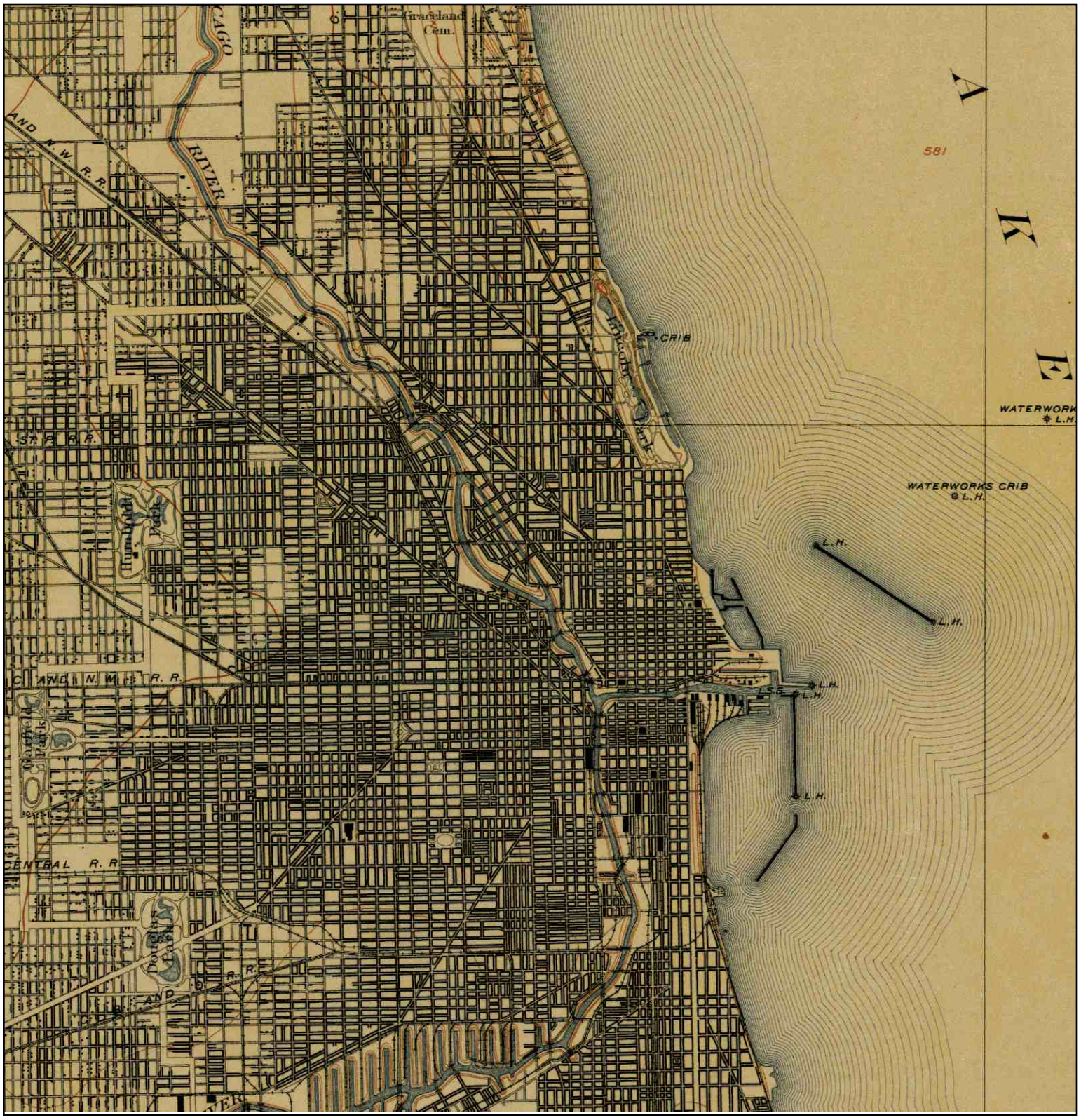
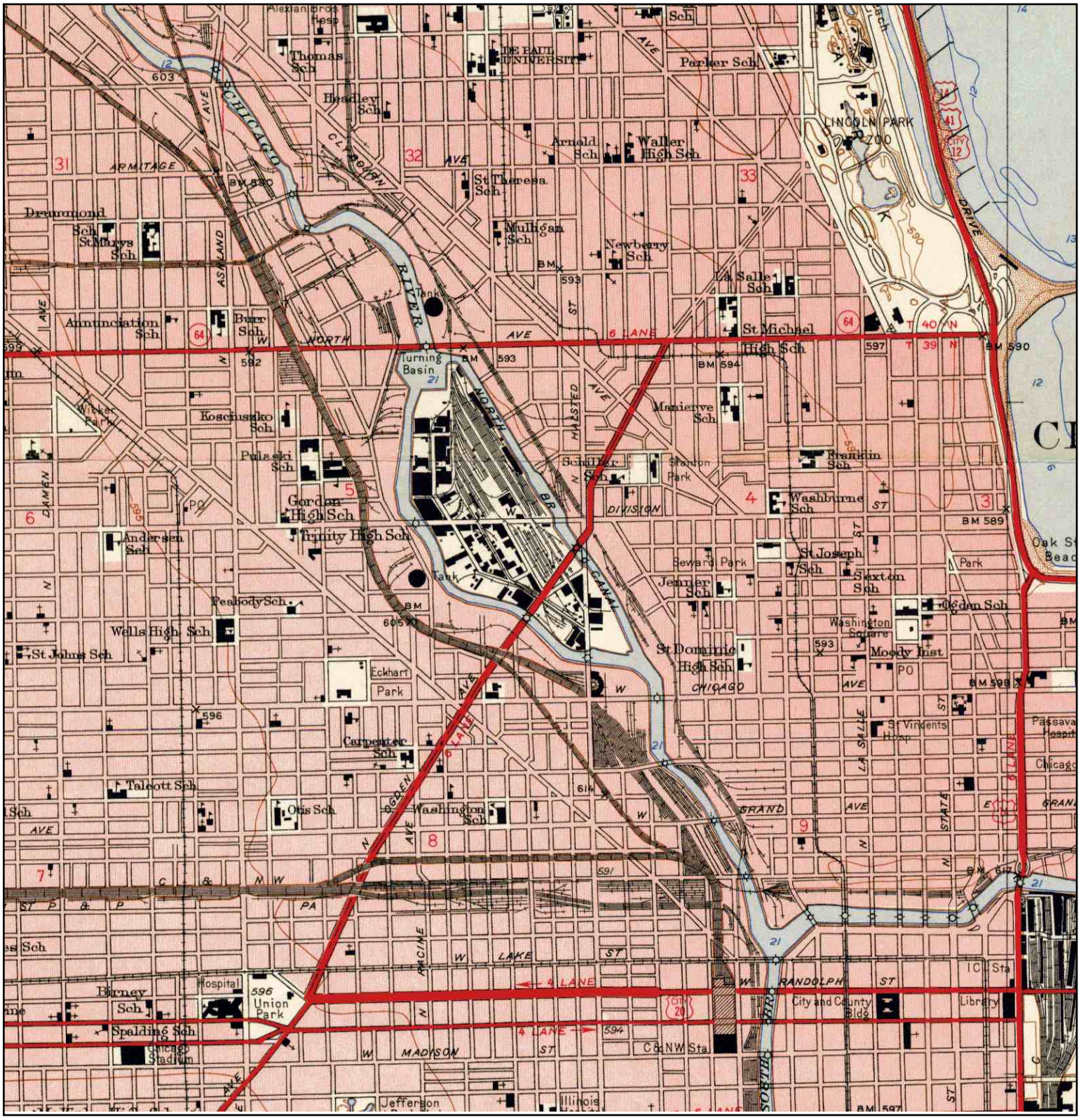
Historical Topographic Map



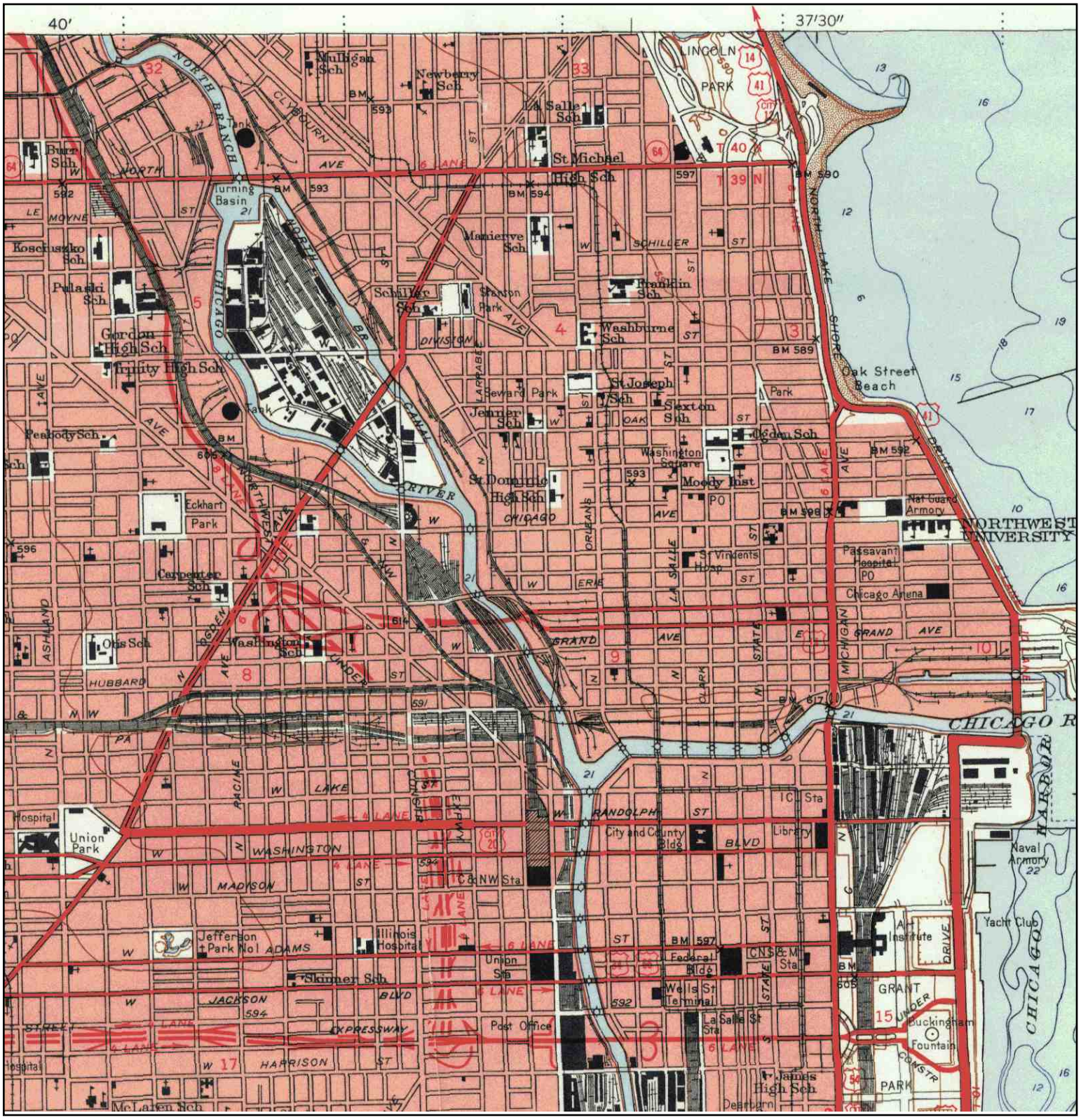
N	TARGET QUAD				
	NAME:	CHICAGO	SITE NAME:	North Station	CLIENT: Natural Resource Technology
	MAP YEAR:	1901	ADDRESS:	1127 Halsted	CONTACT: Robert Karnauskas
				Chicago, IL 60610	INQUIRY#: 3066595.4
	SERIES:	15	LAT/LONG:	41.9021 / -87.646	RESEARCH DATE: 05/12/2011
	SCALE:	1:62500			

Historical Topographic Map



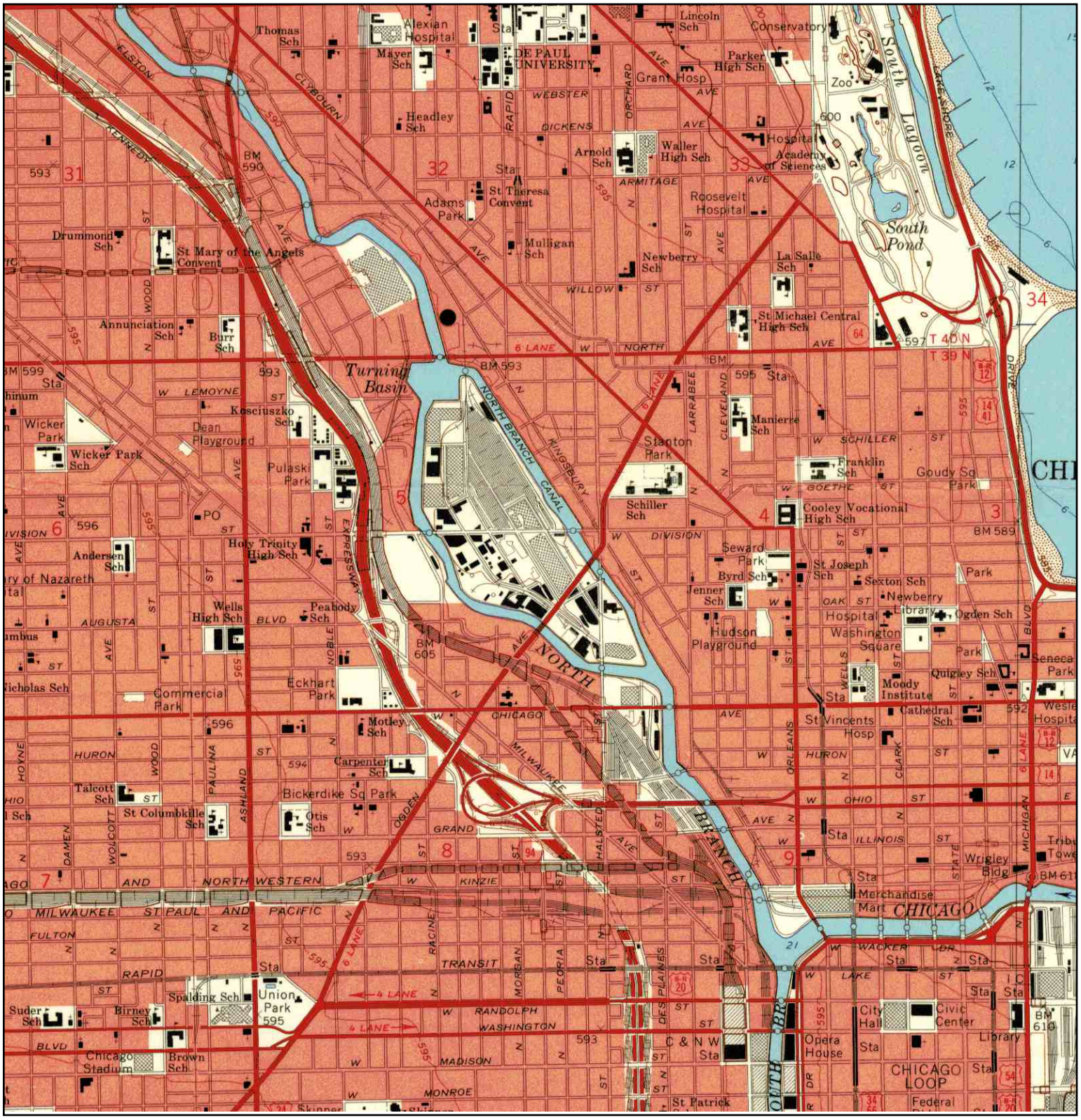
N	TARGET QUAD NAME: CHICAGO LOOP MAP YEAR: 1953 SERIES: 7.5 SCALE: 1:24000	SITE NAME: North Station ADDRESS: 1127 Halsted Chicago, IL 60610 LAT/LONG: 41.9021 / -87.646	CLIENT: Natural Resource Technology CONTACT: Robert Karnauskas INQUIRY#: 3066595.4 RESEARCH DATE: 05/12/2011

Historical Topographic Map



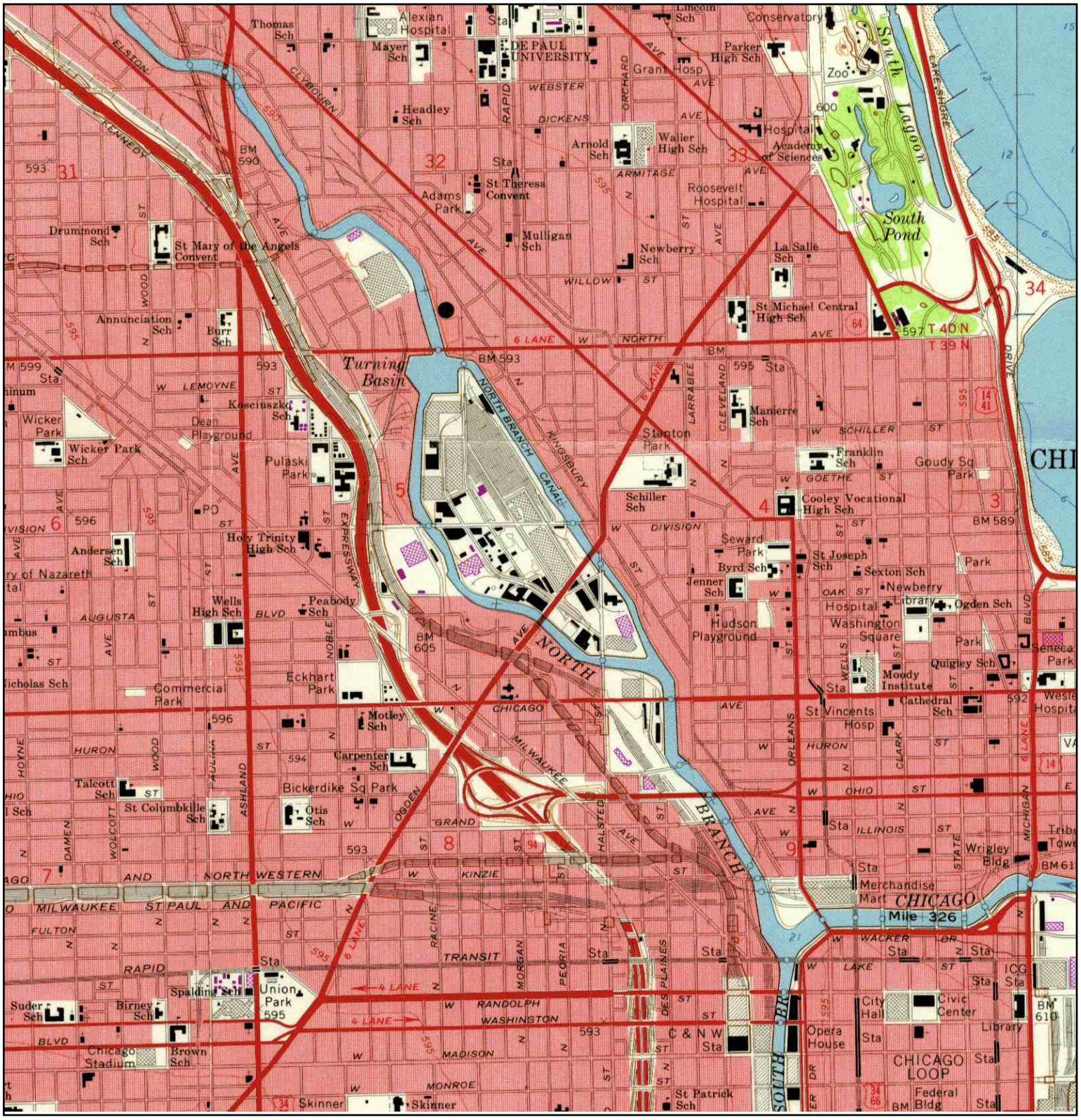
N	TARGET QUAD NAME: CHICAGO VICINITY 2A MAP YEAR: 1953 SERIES: 7.5 SCALE: 1:24000	SITE NAME: North Station ADDRESS: 1127 Halsted Chicago, IL 60610 LAT/LONG: 41.9021 / -87.646	CLIENT: Natural Resource Technology CONTACT: Robert Karnauskas INQUIRY#: 3066595.4 RESEARCH DATE: 05/12/2011

Historical Topographic Map



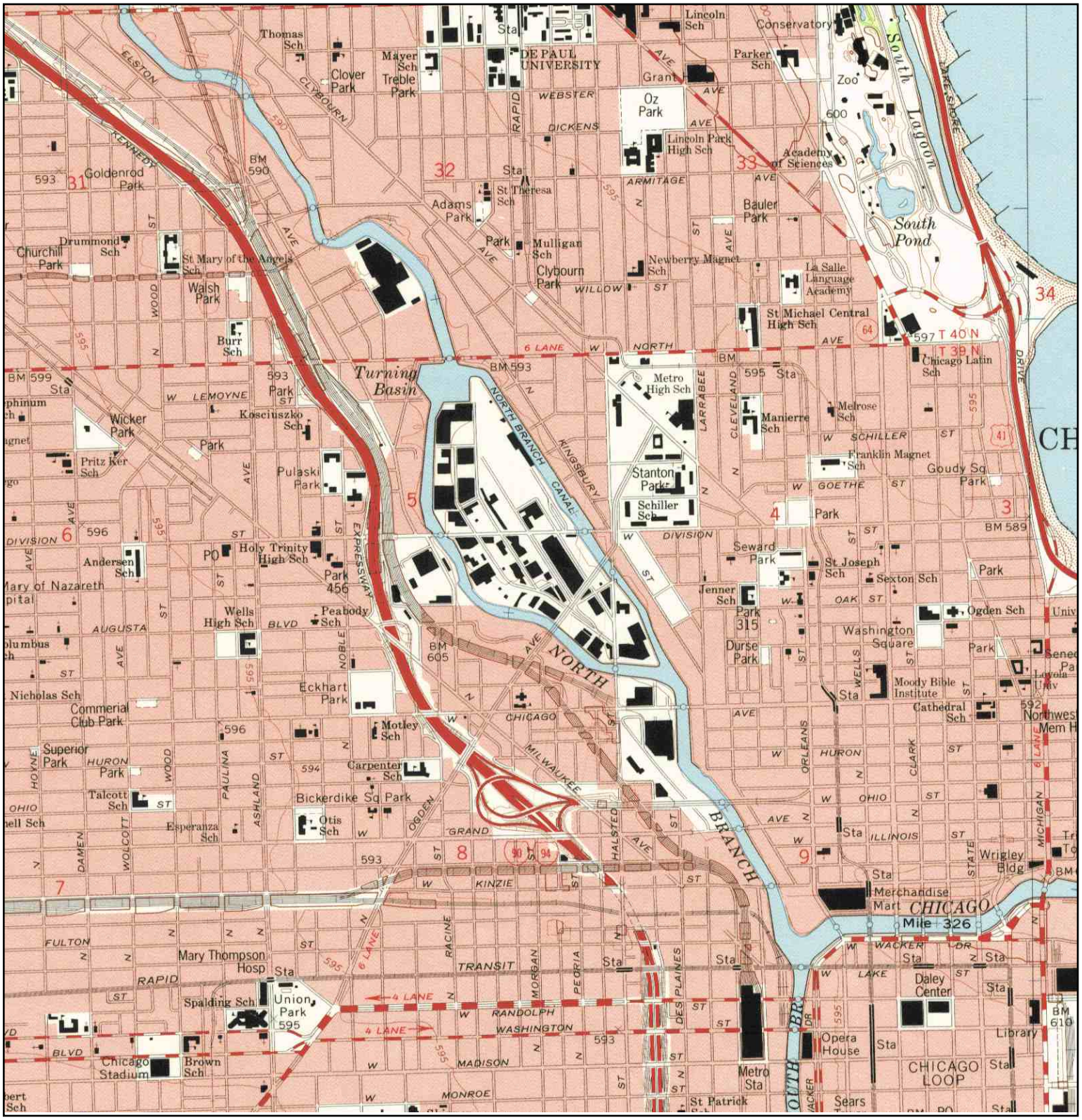
N	TARGET QUAD NAME: CHICAGO LOOP MAP YEAR: 1963 SERIES: 7.5 SCALE: 1:24000	SITE NAME: North Station ADDRESS: 1127 Halsted Chicago, IL 60610 LAT/LONG: 41.9021 / -87.646	CLIENT: Natural Resource Technology CONTACT: Robert Karnauskas INQUIRY#: 3066595.4 RESEARCH DATE: 05/12/2011

Historical Topographic Map



N	TARGET QUAD				
	NAME:	CHICAGO LOOP	SITE NAME:	North Station	CLIENT: Natural Resource Technology
	MAP YEAR:	1972	ADDRESS:	1127 Halsted	CONTACT: Robert Karnauskas
	PHOTOREVISED:	1963		Chicago, IL 60610	INQUIRY#: 3066595.4
	SERIES:	7.5	LAT/LONG:	41.9021 / -87.646	RESEARCH DATE: 05/12/2011
	SCALE:	1:24000			

Historical Topographic Map



N	TARGET QUAD NAME: CHICAGO LOOP MAP YEAR: 1993 SERIES: 7.5 SCALE: 1:24000	SITE NAME: North Station ADDRESS: 1127 Halsted Chicago, IL 60610 LAT/LONG: 41.9021 / -87.646	CLIENT: Natural Resource Technology CONTACT: Robert Karnauskas INQUIRY#: 3066595.4 RESEARCH DATE: 05/12/2011

Historical Topographic Map

N	TARGET QUAD NAME: CHICAGO LOOP MAP YEAR: 1997 SERIES: 7.5 SCALE: 1:24000	SITE NAME: North Station ADDRESS: 1127 Halsted Chicago, IL 60610 LAT/LONG: 41.9021 / -87.646	CLIENT: Natural Resource Technology CONTACT: Robert Karnauskas INQUIRY#: 3066595.4 RESEARCH DATE: 05/12/2011

APPENDIX A4

EDR AIR PHOTO REPORT
(INCLUDED ON CD)

North Station
1127 Halsted
Chicago, IL 60610

Inquiry Number: 3066595.5
May 13, 2011

The EDR Aerial Photo Decade Package

EDR® Environmental Data Resources Inc

440 Wheelers Farms Road
Milford, CT 06461
800.352.0050
www.edrnet.com

EDR Aerial Photo Decade Package

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Date EDR Searched Historical Sources:

Aerial Photography May 13, 2011

Target Property:

1127 Halsted

Chicago, IL 60610

Year	*Scale*	*Details*	*Source*
1952	Aerial Photograph. Scale: 1"=500'	Panel #: 41087-H6, Chicago Loop, IL;/Flight Date: March 29, 1952	EDR
1963	Aerial Photograph. Scale: 1"=750'	Panel #: 41087-H6, Chicago Loop, IL;/Flight Date: November 29, 1963	EDR
1972	Aerial Photograph. Scale: 1"=750'	Panel #: 41087-H6, Chicago Loop, IL;/Flight Date: October 26, 1972	EDR
1984	Aerial Photograph. Scale: 1"=1000'	Panel #: 41087-H6, Chicago Loop, IL;/Flight Date: April 01, 1984	EDR
1988	Aerial Photograph. Scale: 1"=750'	Panel #: 41087-H6, Chicago Loop, IL;/Flight Date: April 12, 1988	EDR
1994	Aerial Photograph. Scale: 1"=750'	Panel #: 41087-H6, Chicago Loop, IL;/Flight Date: March 25, 1994	EDR
1999	Aerial Photograph. Scale: 1"=750'	Panel #: 41087-H6, Chicago Loop, IL;/Flight Date: March 27, 1999	EDR
2005	Aerial Photograph. Scale: 1"=604'	Panel #: 41087-H6, Chicago Loop, IL;/Flight Date: January 01, 2005	EDR
2006	Aerial Photograph. Scale: 1"=604'	Panel #: 41087-H6, Chicago Loop, IL;/Flight Date: January 01, 2006	EDR

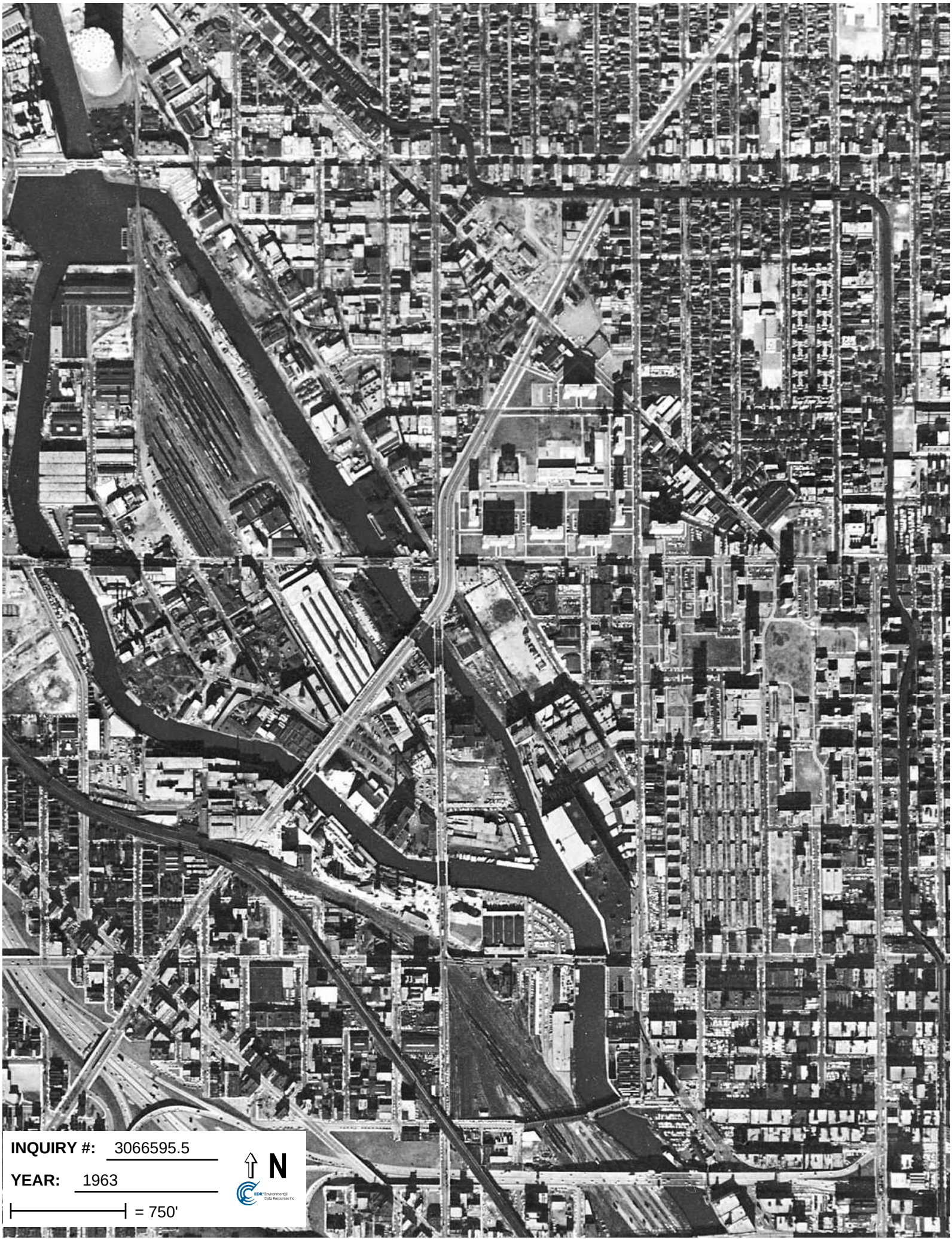
INQUIRY #: 3066595.5

YEAR: 1952

= 500'

N

EDR Environmental Data Resources Inc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YEAR: 1963
= 750'
N

INQUIRY #: 3066595.5
YEAR: 1972
= 750'
N

INQUIRY #: 3066595.5
YEAR: 1984
= 1000'
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YEAR: 1988
= 750'
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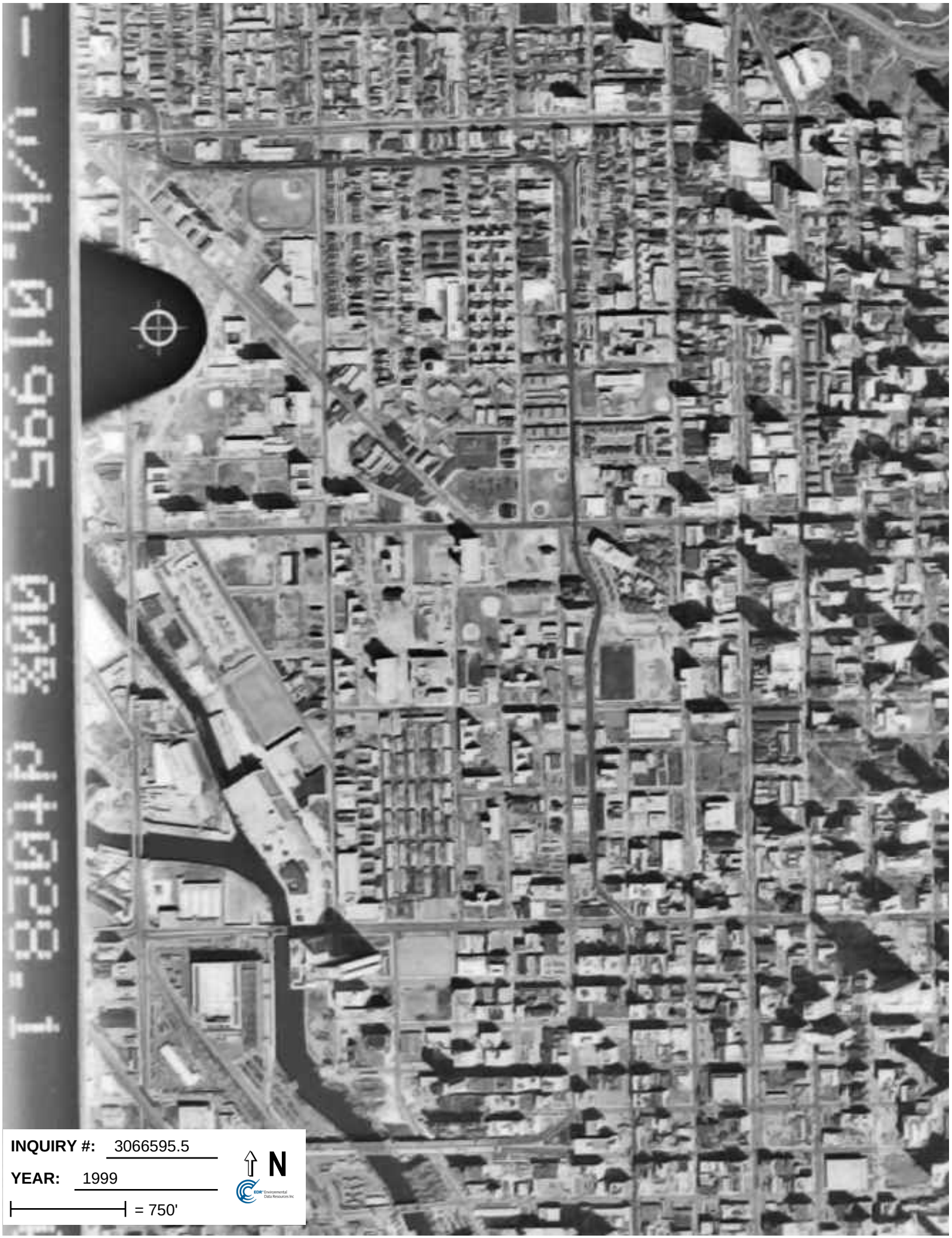
YEAR: 1994
= 750'
N



INQUIRY #: 3066595.5

YEAR: 1999

= 750'

N

EDR Environmental Data Resources Inc

INQUIRY #: 3066595.5
YEAR: 2005
= 604'
N

INQUIRY #: 3066595.5
YEAR: 2006
= 604'
N

APPENDIX A5

PLAT OF SURVEY – ComEd, HALSTED AND DIVISION-HALSTED PARCELS (INCLUDED ON CD)

PLAT OF SURVEY

LOT 5 (EXCEPT THE NORTH 20 FEET THEREOF) AND ALL OF LOTS 6 TO 19, BOTH INCLUSIVE,IN BLOCK 86 IN ELSTON'S ADDITION TO CHICAGO IN SECTIONS 4 AND 5, TOWNSHIP 39 NORTH, RANGE 14 EAST OF THE THIRD PRINCIPAL MERIDIAN; AND THOSE PARTS OF ELSTON'S ADDITION TO CICAGO IN SECTIONS 4 AND 5, TOWNSHIP 39 NORTH, RANGE 14 EAST OF THE THIRD PRINCIPAL MERIDIAN, BOUNDED AND DESCRIBED AS FOLLOWS:

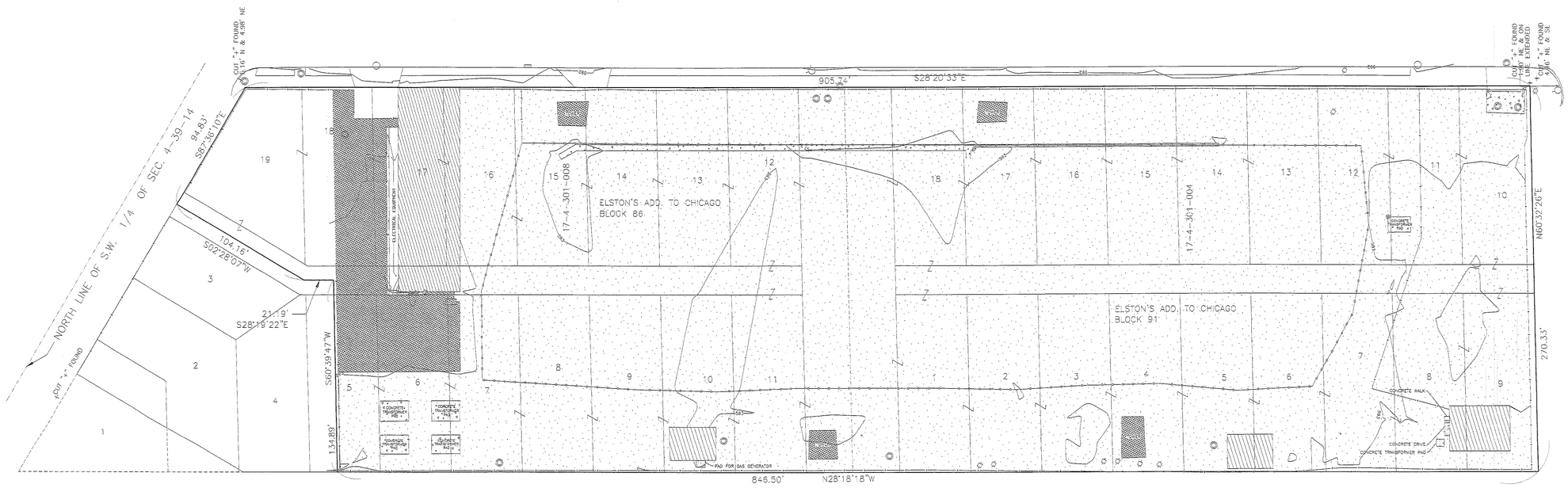
THE PART OF THE VACATED ALLEY EAST OF AND ADJOINING LOTS 5 TO 11 AND WEST OF AND ADJOINING LOTS 12 TO 18, LYING SOUTHERLY OF THE SOUTH LINE EXTENDED EAST OF THE NORTH 20 FEET OF LOT 5, ALL IN BLOCK 86 IN SAID ELSTON'S ADDITION TO CHICAGO; ALSO THAT PART F THE VACATED ALLEY WESTERLY AND WEST OF AND ADJOINING LOTS 18 AND 19 AND EAST OF AND EASTERLY OF THE CENTER LINE OF SAID VACATED ALLEY, LYING NORTHERLY OF THE SOUTH LINE EXTENDED EAST OF THE NORTH 20 FEET OF LOT 5, ALL IN BLOCK 86 IN SAID ELSTON'S ADDITION TO CHICAGO; ALSO, THAT PART OF THE NORTHERLY HALF OF VACATED HAINES STREET, SOUTH OF AND ADJOINING BLOCK 86 OF SAID ELSTON'S ADDITION TO CHICAGO, LYING BETWEEN THE EAST AND WEST LINES OF SAID BLOCK 86 EXTENDED SOUTH.

LOTS 1 TO 18, BOTH INCLUSIVE, IN BLOCK 91 IN ELSTON'S ADDITION TO CHICAGO IN SECTIONS 4 AND 5, TOWNSHIP 39 NORTH, RANGE 14 EAST OF THE THIRD PRINCIPAL MERIDIAN; AND THOSE PARTS OF ELSTON'S ADDITION TO CHICAGO IN SECTIONS 4 AND 5, TOWNSHIP 39 NORTH, RANG 14 EAST OF THE THIRD PRINCIPAL MERIDIAN BOUNDED AND DESCRIBED AS FOLLOWS:

ALL OF THE VACATED ALLEY LYING EAST OF AND ADJOINING LOTS 1 TO 9 AND WEST OF AND ADJOINING LOTS 10 TO 18 IN BLOCK 91 IN SAID ELSTON'S ADDITION TO CHICAGO; ALSO, THAT PART OF THE SOUTHERLY HALF OF VACATED HAINES STREET, NORTH OF AND ADJOINING BLOCK 91 OF AID ELSTON'S ADDITION TO CHICAGO, LYING BETWEEN THE EAST AND WEST LINES OF SAID BLOCK 91 EXTENDED NORTH.

LEGEND

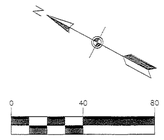
- CATCH BASIN OR AREA DRAIN
- INLET
- LIGHT POLE
- HYDRANT
- ELECTRIC BOX
- MANHOLE SANITARY
- ELECTRICAL BUS STRUCTURE
- MONITORING WELL
- PROBE / BORING
- SURVEY CONTROL POINTS
- UTILITY POLE
- FENCE LINE
- CONCRETE SURFACE
- GRAVEL SURFACE
- BITUMINOUS SURFACE
- BUILDING



TOTAL AREA = 5.484 ACRES (238,879 sq. ft.)

NOTE:

1. THE HORIZONTAL CONTROL IS AN ASSUMED SYSTEM PROVIDED BY THE CLIENT.
2. THE VERTICAL CONTROL IS BASED ON CCD MON 4568, EL 13.994, THEN ADJUSTED TO THE MEAN SEA LEVEL BY ADDING 579.88 (1935 ADJ).



STATE OF ILLINOIS }
} S.S.
COUNTY OF COOK }

SURVEYOR'S CERTIFICATE

I, ZHONG CHEN, AN ILLINOIS PROFESSIONAL LAND SURVEYOR, HEREBY CERTIFY THAT I HAVE SURVEYED THE ABOVE DESCRIBED TRACT OF LAND AND THAT THIS PLAT IS A CORRECT REPRESENTATION OF SAID SURVEY. DIMENSIONS ARE IN FEET AND DECIMAL PARTS THEREOF.

ZHONG CHEN
035-003299
LICENSED PROFESSIONAL LAND SURVEYOR
ILLINOIS

ZHONG CHEN
ILLINOIS PROFESSIONAL LAND SURVEYOR NO. 035-003299

CONSULTANT

DYNASTY GROUP, INC.
205 W. WACKER DRIVE, SUITE 1020
CHICAGO, ILLINOIS 60606
TEL: (312) 704-1970
FAX: (312) 704-1977

NO.	BY	DATE	DESCRIPTION
3	JM	10/29/01	REVISIONS PER CASANDRA BERG
2	JM	10/25/01	REVISIONS PER CASANDRA BERG
1	CS	9/19/01	REVISIONS PER CASANDRA BERG

REVISIONS

CLIENT: BURNS & MCDONNELL

PROPERTY LOCATION: DIVISION & KINGSBURY CHICAGO, ILLINOIS

DRAWN	DC, JM
CHECKED	ZC
APPROVED	DYNASTY GROUP, INC.
DATE	10/29/01
SCALE	1" = 40'
CONTRACT NO.	
PROJECT NO.	01132

SHEET NO. 1 of 1

SURVEYOR'S EXHIBIT

LEGAL DESCRIPTION

PARCEL 1:
THAT PART OF LOTS 1 AND 2 LYING SOUTHEASTERLY OF THE SOUTHEASTERLY LINE OF OGDEN AVENUE AS WIDENED AND EXTENDED IN BLOCK 85 IN ELSTON ADDITION TO CHICAGO IN THE WEST HALF OF THE SOUTHWEST QUARTER OF SECTION 4, TOWNSHIP 39 NORTH, RANGE 14, EAST OF THE THIRD PRINCIPAL MERIDIAN, IN COOK COUNTY, ILLINOIS. (EXCEPTING THEREFROM THAT PART CONVEYED TO THE CITY OF CHICAGO BY WARRANTY DEED RECORDED FEBRUARY 3, 2010 AS DOCUMENT 1003422014.)

PARCEL 2:
LOTS 3, 4, 5, 6 AND 7 IN BLOCK 85 IN ELSTON ADDITION TO CHICAGO IN THE WEST HALF OF THE SOUTHWEST QUARTER OF SECTION 4, TOWNSHIP 39 NORTH, RANGE 14, EAST OF THE THIRD PRINCIPAL MERIDIAN, IN COOK COUNTY, ILLINOIS. (EXCEPTING THEREFROM THAT PART CONVEYED TO THE CITY OF CHICAGO BY WARRANTY DEED RECORDED FEBRUARY 3, 2010 AS DOCUMENT 1003422014.)

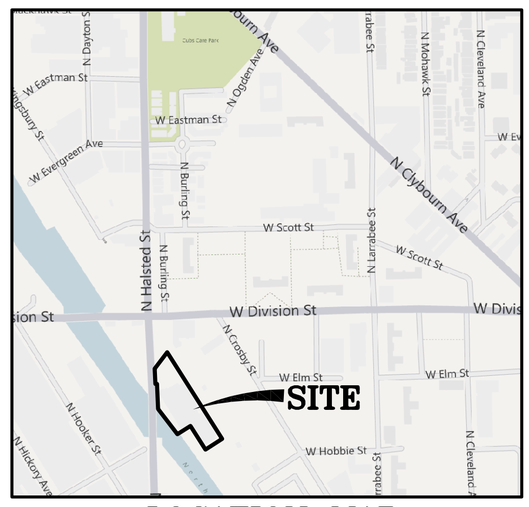
PARCEL 3:
THE NORTHWEST HALF OF VACATED HAINES STREET, SOUTHEASTERLY OF AND ADJOINING LOT 7 IN BLOCK 85 IN ELSTON ADDITION TO CHICAGO IN THE WEST HALF OF THE SOUTHWEST QUARTER OF SECTION 4, TOWNSHIP 39 NORTH, RANGE 14, EAST OF THE THIRD PRINCIPAL MERIDIAN, IN COOK COUNTY, ILLINOIS.

PARCEL 4:
THE EASTERLY 107 FEET (AS MEASURED ALONG THE LOT LINES) OF LOTS 1, 2 AND 3 AND ALSO THAT PART OF THE SOUTHEASTERLY HALF OF VACATED HAINES STREET NORTH OF AND ADJOINING SAID LOT 1, LYING BETWEEN THE EAST AND WEST LINES OF SAID LOT 1, EXTENDED NORTH, ALL IN BLOCK 96 IN ELSTON ADDITION TO CHICAGO IN THE WEST HALF OF THE SOUTHWEST QUARTER OF SECTION 4, TOWNSHIP 39 NORTH, RANGE 14, EAST OF THE THIRD PRINCIPAL MERIDIAN, IN COOK COUNTY, ILLINOIS.

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.



LOCATION MAP

N

FLOOD HAZARD NOTE:

ACCORDING TO THE FEDERAL EMERGENCY MANAGEMENT AGENCY FIRM COMMUNITY PANEL NUMBER 17031C0419J, WITH A MAP REVISION DATE OF AUGUST 19, 2008, PART OF THE SURVEYED PROPERTY LIES WITHIN AN AREA DESIGNATED AS ZONE X (UNSHADED) AND PART OF THE SURVEYED PROPERTY LIES WITHIN AN AREA DESIGNATED AS ZONE A. ZONE X (UNSHADED) IS DEFINED AS AREAS DETERMINED TO BE OUTSIDE THE 0.2% ANNUAL CHANCE FLOODPLAIN AND ZONE A IS DEFINED AS SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD WITH NO BASE FLOOD ELEVATIONS DETERMINED, PER THE FLOOD INSURANCE RATE MAP (FIRM). THESE MAPS DO NOT NECESSARILY SHOW ALL AREAS SUBJECT TO FLOODING IN THE COMMUNITY OR ALL PLANIMETRIC FEATURES OUTSIDE SPECIAL FLOOD HAZARD AREAS. THIS DOES NOT GUARANTEE THAT THE SURVEYED PROPERTY WILL OR WILL NOT FLOOD.

LEGEND

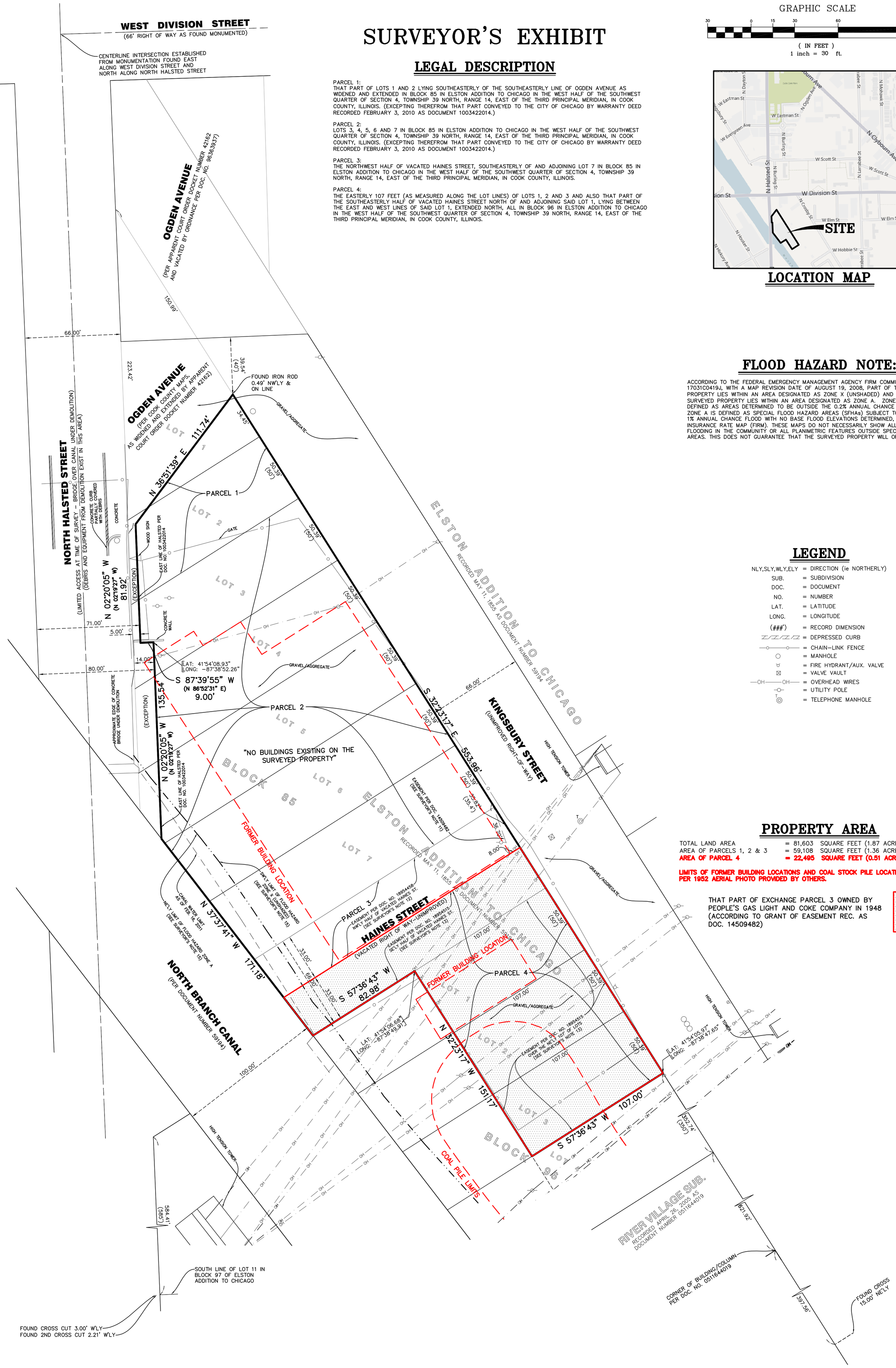
NLY,SLY,WLY,ELY	=	DIRECTION (ie NORTHERLY)
SUB.	=	SUBDIVISION
DOC.	=	DOCUMENT
NO.	=	NUMBER
LAT.	=	LATITUDE
LONG.	=	LONGITUDE
(###')	=	RECORD DIMENSION
	=	DEPRESSED CURB
—o—o—	=	CHAIN–LINK FENCE
○	=	MANHOLE
☌	=	FIRE HYDRANT/AUX. VALVE
⊠	=	VALVE VAULT
—OH—OH—	=	OVERHEAD WIRES
—○—	=	UTILITY POLE
T ◎	=	TELEPHONE MANHOLE

PROPERTY AREA

TOTAL LAND AREA = 81,603 SQUARE FEET (1.87 ACRES), MORE OR LESS
AREA OF PARCELS 1, 2 & 3 = 59,108 SQUARE FEET (1.36 ACRES), MORE OR LESS
AREA OF PARCEL 4 = 22,495 SQUARE FEET (0.51 ACRES), MORE OR LESS

LIMITS OF FORMER BUILDING LOCATIONS AND COAL STOCK PILE LOCATION ARE SHOWN PER 1952 AERIAL PHOTO PROVIDED BY OTHERS.

THAT PART OF EXCHANGE PARCEL 3 OWNED BY PEOPLE'S GAS LIGHT AND COKE COMPANY IN 1948 (ACCORDING TO GRANT OF EASEMENT REC. AS DOC. 14509482)



26002	SHEET 1 OF 1	SURVEYOR'S EXHIBIT
		DIVISION–HALSTED L.L.C. – EXCHANGE PARCEL 3
		1127 N. HALSTED STREET, CHICAGO, ILLINOIS

"WE GET THE CORNERS OTHER PEOPLE CUT!"

LAND SURVEYING, MAPPING AND CONSTRUCTION STAKING
SIGHT ON SOLUTIONS,INC.
891 BLACK CHERRY LANE, ROUND LAKE HEIGHTS, IL 60073
PHONE:847.313.5744 FAX:847.201.8637 www.sightonsolutions.com

DATE	REVISIONS	DRAWN BY	CHECK BY

SCALE: 1"=30' DATE: 03/14/11 CHECKED BY: M.S.U. DRAWN BY: M.S.U.

Surveyor's email: mikeu@sightonsolutions.com

APPENDIX A6

ECOLOGICAL SURVEY DATA

U.S. Fish and Wildlife Service

National Wetlands Inventory

NWI Wetlands Mapper - North Station OU

Jul 19, 2011

Wetlands

- Freshwater Emergent
- Freshwater Forested/Shrub
- Estuarine and Marine Deepwater
- Estuarine and Marine
- Freshwater Pond
- Lake
- Riverine
- Other

Riparian

- Herbaceous
- Forested/Shrub

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

User Remarks:

EcoCAT
Ecological Compliance Assessment Tool

Applicant: Peoples Gas Light
Contact: Jamie Nuthals
Address: 130 East Randolph Street,
Chicago, IL 60601

IDNR Project #: 1113897
Date: 06/28/2011

Project: People's Gas & Coke Station
Address: North Crosby, West Division, West Hobbie Streets and North Branch Canal, Chicago

Description: The work is for preparing a site-specific work plan that will outline proposed groundwater and soil sampling activities that we would like to conduct on site. This information will be used for planning.

Natural Resource Review Results

This project was submitted for information only. It is not a consultation under Part 1075.

The Illinois Natural Heritage Database shows the following protected resources may be in the vicinity of the project location:

Peregrine Falcon *(Falco peregrinus)*

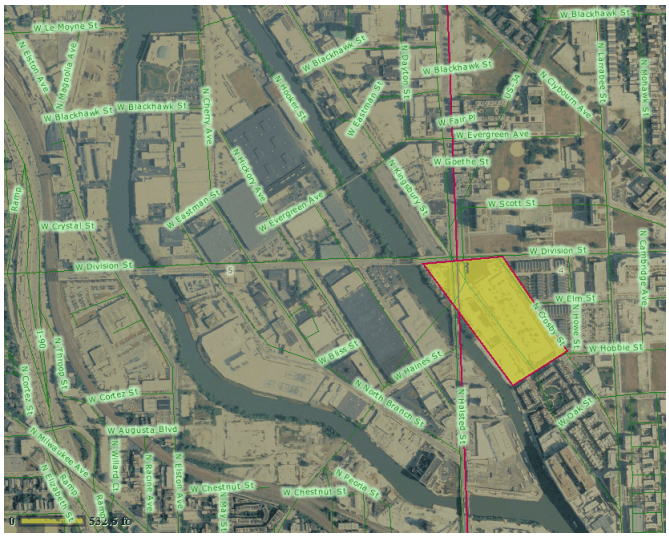
Location

The applicant is responsible for the accuracy of the location submitted for the project.

County: Cook

Township, Range, Section:

39N, 14E, 4 39N, 14E, 5



IL Department of Natural Resources Contact
Impact Assessment Section
217-785-5500
Division of Ecosystems & Environment

Disclaimer

The Illinois Natural Heritage Database cannot provide a conclusive statement on the presence, absence, or condition of natural resources in Illinois. This review reflects the information existing in the Database at the time of this inquiry, and should not be regarded as a final statement on the site being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments. If additional protected resources are encountered during the project's implementation, compliance with applicable statutes and regulations is required.

Terms of Use

By using this website, you acknowledge that you have read and agree to these terms. These terms may be revised by IDNR as necessary. If you continue to use the EcoCAT application after we post changes to these terms, it will mean that you accept such changes. If at any time you do not accept the Terms of Use, you may not continue to use the website.

1. The IDNR EcoCAT website was developed so that units of local government, state agencies and the public could request information or begin natural resource consultations on-line for the Illinois Endangered Species Protection Act, Illinois Natural Areas Preservation Act, and Illinois Interagency Wetland Policy Act. EcoCAT uses databases, Geographic Information System mapping, and a set of programmed decision rules to determine if proposed actions are in the vicinity of protected natural resources. By indicating your agreement to the Terms of Use for this application, you warrant that you will not use this web site for any other purpose.

2. Unauthorized attempts to upload, download, or change information on this website are strictly prohibited and may be punishable under the Computer Fraud and Abuse Act of 1986 and/or the National Information Infrastructure Protection Act.

3. IDNR reserves the right to enhance, modify, alter, or suspend the website at any time without notice, or to terminate or restrict access.

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EcoCAT operates on a state of Illinois computer system. We may use software to monitor traffic and to identify unauthorized attempts to upload, download, or change information, to cause harm or otherwise to damage this site. Unauthorized attempts to upload, download, or change information on this server is strictly prohibited by law. Unauthorized use, tampering with or modification of this system, including supporting hardware or software, may subject the violator to criminal and civil penalties. In the event of unauthorized intrusion, all relevant information regarding possible violation of law may be provided to law enforcement officials.

Privacy

EcoCAT generates a public record subject to disclosure under the Freedom of Information Act. Otherwise, IDNR uses the information submitted to EcoCAT solely for internal tracking purposes.

APPENDIX A7

HABITAT ASSESSMENT FORMS

CHECKLIST FOR ECOLOGICAL ASSESSMENT/SAMPLING

I. SITE DESCRIPTION

1. Site Name: Former North Station Manufactured Gas Plant (MGP) Site Operable Unit (OU)

   Location: Section 4, Township 39 North, Range 14 East

   County: Cook City: Chicago State: Illinois

2. Latitude: _____ Longitude: _____

3. What is the approximate area of the site? Approximately 9 acres

4. Is this the first site visit? ✓ yes ☐ no. If no, attach trip report of previous site visit(s), if available.

   Date(s) of previous site visit(s): _____

5. Please attach to the checklist USGS topographic map(s) of the site, if available.

   Not provided.

6. Are aerial or other site photographs available? ✓ yes ☐ no. If yes, please attach any available photo(s) to the site map at the conclusion of this section.

   See attached photograph log sheets.

7.

The land use on the site is:	The area surrounding the site is: 0.2 mile radius
0 % Urban	0 % Urban
0 % Rural	0 % Rural
0 % Residential	50 % Residential
100 % Industrial (☐ light ✓heavy)	50 % Industrial (☐ light ✓ heavy)
0 % Agricultural	0 % Agricultural
(*Crops*: _____)	(*Crops*: None)
0 % Recreational	0 % Recreational
(Describe; note if it is a park, etc.)	*(Describe; note if it is a park, etc.)*
0 % Undisturbed	0 % Undisturbed
0 % Other (vacant / abandoned)	0 % Other

8. Has any movement of soil taken place at the site? ✓ yes ☐ no. If yes, please identify the most likely cause of this disturbance:

_____	Agricultural Use	X_____	Heavy Equipment	_____	Mining
_____	Natural Events	_____	Erosion	X_____	Other

Please describe: Site was historically filled and is covered with gravel over most of the surface. Land use is industrial in nature and includes an electrical substation, equipment storage, and parking areas.

9. Do any potentially sensitive environmental areas exist adjacent to or in proximity to the site, e.g., Federal and State parks, National and State monuments, wetlands, prairie potholes? *Remember, flood plains and wetlands are not always obvious; do not answer "no" without confirming information.*

No sensitive areas exist on the site or adjacent to the site. The site is located in an urban area of the City of Chicago adjacent to the Chicago River.

Please provide the source(s) of information used to identify these sensitive areas, and indicate their general location on the site map.

General observation made on July 19, 2011.

10. What type of facility is located at the site?

☐ Chemical ☐ Manufacturing ☐ Mixing ☐ Waste disposal

✓ Other (specify) Vacant land, substation, outdoor storage area for construction equipment.

11. What are the suspected contaminants of concern at the site? If known, what are the maximum concentration levels?

Chemical constituents of potential concern (COPCs) at the site include benzene, polynuclear aromatic hydrocarbons (PAHs), and selected metals detected in soil, sediment, and groundwater samples. Refer to the details provided in the SSWP.

12. Check any potential routes of off-site migration of contaminants observed at the site:

☐ Swales ☐ Depressions ☐ Drainage ditches

☐ Runoff ☐ Windblown particulates ☐ Vehicular traffic

✓ Other (specify) No potential routes of offsite migration observed on site.

13. If known, what is the approximate depth to the water table? 3–15 ft below ground surface (bgs)

14. Is the direction of surface runoff apparent from site observations? ☐ yes ✓ no. If yes, to which of the following does the surface runoff discharge: Indicate all that apply.

☐ Surface water ☐ Groundwater ☐ Sewer ☐ Collection impoundment

15. Is there a navigable waterbody or tributary to a navigable waterbody? ✓ yes ☐ no.

16. Is there a waterbody anywhere on or in the vicinity of the site? If yes, also complete Section III: Aquatic Habitat Checklist - Non-Flowing Systems and/or Section IV: Aquatic Habitat Checklist - Flowing Systems.

✓ yes (Chicago River located on site) ☐ no

17. Is there evidence of flooding? ☐ yes ✓ no. *Wetlands and flood plains are not always obvious; do not answer "no" without confirming information.* If yes, complete Section V: Wetland Habitat Checklist.

18. If a field guide was used to aid any of the identifications, please provide a reference. Also, estimate the time spent identifying fauna. (Use a blank sheet if additional space is needed for text.)

Site is completely developed with no natural areas of vegetation present onsite.

19. Are any threatened and/or endangered species (plant or animal) known to inhabit the area of the site? ☐ yes ✓ no. *If yes, you are required to verify this information with the U.S. Fish and Wildlife Service.* If species' identities are known, please list them next.

Site is completely developed with no natural areas that could provide habitat for threatened and/or endangered species.

20. Record weather conditions at the time this checklist was prepared:

DATE: 7/19/2011

90°F Temperature (°C/°F) 85 °F Normal daily high temperature

Light and variable 0–5 mph Wind (direction/speed) None Precipitation (rain, snow)

Mostly sunny Cloud cover

IA. SUMMARY OF OBSERVATIONS AND SITE SETTING

On July 19, 2011, an Exponent environmental biologist conducted a habitat assessment on the active urban upland portion of the OU during a site visit to the OU. Observations were made from properties for which there was access on the day of the site visit including the Kingsbury Street Parcel and public right-of-ways. There was very limited ecological habitat on or adjacent to the upland area of the OU because of the extensive urban development. The upland portion of the site is composed of parcels that are developed and the ground surface is primarily covered with gravel with limited vegetation other than some weed species and trees growing in isolated patches along fence lines. The majority of the OU is composed of an electrical substation, and other parcels used to store construction equipment. No terrestrial ecological receptors were observed onsite during the visit.

A complete habitat assessment of the river portion of the OU could not be completed during this initial visit because of access restrictions to the river. However, during the site reconnaissance, the general condition of the river and riverbank was observed and initial observations of ecological receptors using the river were made. The river along the OU is constrained by vertical walls or steep rocky banks and there is very limited vegetation in the riparian zone. The vegetation present on the banks is limited to isolated clumps of deciduous trees or weed species along the Division Halsted Parcel (refer to attached pictures). Waterfowl (mallard ducks and Canada geese) were observed in the Chicago River, but no other aquatic ecological receptors were observed in the river on the day of the reconnaissance. There is limited nesting habitat for birds on the site or adjacent properties because of the limited vegetation present. The North Branch of the Chicago River is generally 4–8 ft deep as reported in the Completion Report (NRT 2011). However, in the area of the OU, the center channel of the river is very deep (greater than 10 ft deep) based on elevation information collected at three sediment borings provided in Appendix B of the Completion Report. Reconstruction of a bridge was ongoing just upstream of the OU on the day the reconnaissance was performed.

Completed by Michael W. Kierski Affiliation Exponent

Additional Preparers _____

Site Manager _____

Date 7-19-2011

II. TERRESTRIAL HABITAT CHECKLIST

IIA. WOODED

1. Are there any wooded areas at the site? ☐ yes ✓ no. If no, go to Section IIB: Shrub/Scrub.

2. What percentage or area of the site is wooded? (0.0% 0.0 acres). Indicate the wooded area on the site map which is attached to a copy of this checklist. Please identify what information was used to determine the wooded area of the site.

3. What is the dominant type of vegetation in the wooded area? (Circle one: Evergreen/Deciduous/Mixed) Provide a photograph, if available.

   Dominant plant, if known: .

4. What is the predominant size of the trees at the site? Use diameter at breast height.

   ☐ 0-6 in. ☐ 6-12 in. ☐ >12 in.

5. Specify type of understory present, if known. Provide a photograph, if available.

IIB. SHRUB/SCRUB

1. Is shrub/scrub vegetation present at the site? ☐ yes ✓no. If no, go to Section IIC: Open Field.

2. What percentage of the site is covered by scrub/shrub vegetation? (0.0% 0.0 acres). Indicate the areas of shrub/scrub on the site map. Please identify what information was used to determine this area.

3. What is the dominant type of scrub/shrub vegetation, if known? Provide a photograph, if available.

4. What is the approximate average height of the scrub/shrub vegetation?

   ☐ 0-2 ft. ☐ 2-5 ft. ☐ >5 ft.

5. Based on site observations, how dense is the scrub/shrub vegetation?

   ☐ Dense ☐ Patchy ☐ Sparse

IIC. OPEN FIELD

1. Are there open (bare, barren) field areas present at the site? ☐ yes ✓ no. If yes, please indicate the type below:

   ☐ Prairie/plains ☐ Savannah ☐ Old field ☐ Other (specify)

2. What percentage of the site is open field? (0.0 % 0.0 acres). Indicate the open field on the site map.

3. What is/are the dominant plant(s)? Provide a photograph, if available.

4. What is the approximate average height of the dominant plant?

5. Describe the vegetation cover: ☐ Dense ☐ Sparse ☐ Patchy

IID. MISCELLANEOUS

1. Are other types of terrestrial habitats present at the site, other than woods, scrub/shrub, and open field?
   ☐ yes ✓ no. If yes, identify and describe them below.

   The site does not contain terrestrial habitat as the parcels have been completely covered by gravel, buildings, and/or concrete structures.

2. Describe the terrestrial miscellaneous habitat(s) and identify these area(s) on the site map.

3. What observations, if any, were made at the site regarding the presence and/or absence of insects, fish, birds, mammals, etc.?

4. Review the questions in Section I to determine if any additional habitat checklists should be completed for this site.

III. AQUATIC HABITAT CHECKLIST – NON-FLOWING SYSTEMS

Note: Aquatic systems are often associated with wetland habitats. Please refer to Section V, Wetland Habitat Checklist.

1. What type of open-water, non-flowing system is present at the site? Not applicable

   ☐ Natural (pond, lake)

   ☐ Artificially created (lagoon, reservoir, canal, impoundment)

2. If known, what is the name(s) of the waterbody(ies) on or adjacent to the site?

   _____

3. If a waterbody is present, what are its known uses (e.g.: recreation, navigation, etc.)?

4. What is the approximate size of the waterbody(ies)? _____acre(s).

5. Is any aquatic vegetation present? ☐ yes ☐ no. If yes, please identify the type of vegetation present is known.

   ☐ Emergent ☐ Submergent ☐ Floating

6. If known, what is the dept of the water? _____

7. What is the general composition of the substrate? Check all that apply.

   ☐ Bedrock ☐ Sand (coarse) ☐ Muck (fine/black)

   ☐ Boulder (> 10 in.) ☐ Silt (fine) ☐ Debris

   ☐ Cobble (2.5–10 in.) ☐ Marl (shells) ☐ Detritus

   ☐ Gravel (0.1–2.5 in.) ☐ Clay (slick) ☐ Concrete

   ☐ Other (specify) _____

8. What is the source of water in the waterbody?

   ☐ River/Stream/Creek ☐ Groundwater ☐ Other (specify)_____

   ☐ Industrial discharge ☐ Surface runoff

9. Is there a discharge from the site to the waterbody? ☐ yes ☐ no. If yes, please describe this discharge and its path.

10. Is there a discharge from the waterbody? ☐ yes ☐ no. If yes, and the information is available, identify from the list below the environment into which the waterbody discharges.

☐ River/Steam/Creek	☐ Onsite	☐ Offsite	Distance _____
☐ Groundwater	☐ Onsite	☐ Offsite	
☐ Wetlands	☐ Onsite	☐ Offsite	Distance _____
☐ Impoundment	☐ Onsite	☐ Offsite	

11. Identify any field measurements and observations of water quality that were made. For those parameters for which data were collected provide the measurement and the units of measure below:

_____ Area

_____ Depth (average)

_____ Temperature (depth of the water at which the reading was taken) _____

_____ pH

_____ Dissolved oxygen

_____ Salinity

_____ Turbidity (clear, slightly turbid, turbid, opaque) (Secchi disk depth _____, visual)

_____ Other (specify)

12. Describe observed color and area of coloration.

13. Mark the open-water, non-flowing system on the site map attached to his checklist.

14. What observations, if any, were made at the waterbody regarding the presence and/or absence of benthic macroinvertebrates, fish, birds, mammals, etc.?

IV. AQUATIC HABITAT CHECKLIST – FLOWING SYSTEMS

Note: Aquatic systems are often associated with wetland habitats. Please refer to Section 4, Wetland Habitat Checklists.

1. What type(s) of flowing water system(s) is (are) present at the site?

✓ River	☐ Stream	☐ Creek
☐ Dry wash	☐ Arroyo	☐ Brook
☐ Artificially created (ditch, etc.)	☐ Intermittent Stream	☐ Channeling
	☐ Other (specify) _____	

2. If known, what is the name of the waterbody? North Branch of the Chicago River

3. For natural systems, are there any indicators of physical alteration (e.g., channeling, debris, etc.)?

✓ yes ☐ no. If yes, please describe indicators that were observed.

The river is constrained by vertical walls and steep rock lined banks. The river has been dramatically altered from its normal course and flow regime.

4. What is the general composition of the substrate? Check all that apply. No observations made.

☐ Bedrock	☐ Sand (coarse)	☐ Muck (fine/black)
☐ Boulder (> 10 in.)	☐ Silt (fine)	☐ Debris
☐ Cobble (2.5–10 in.)	☐ Marl (shells)	☐ Detritus
☐ Gravel (0.1–2.5 in.)	☐ Clay (slick)	☐ Concrete

☐ Other (specify) _____.

5. What is the condition of the bank (e.g., height, slope, extent of vegetation cover)?

The banks are steep and covered with rock rip rap or have vertical sheet pile walls.

6. Is the system influenced by tides? ☐ yes ✓no. What information was used to make this determination?

7. Is the flow intermittent? ☐ yes ✓ no. If yes, please note the information that was used in making this determination.

8. Is there a discharge from the site to the waterbody? ✓ yes ☐ no. If yes, please describe the discharge and its path.

Mainly sheet flow from the gravel storage yard adjacent to the river. The majority of the surface water flow is captured by combined storm/sanitary sewer systems that convey the water to the deep tunnel.

9. Is there a discharge from the waterbody? ✓ yes ☐ no. If yes, and the information is available, please identify what the waterbody discharges to and whether the discharge is on-site or off-site.

There is no nearby discharge point for the Chicago River. The river flows towards the Illinois River.

10. Identify any field measurements and observations of water quality that were made. For those parameters for which data were collected, provide the measurement and the units of measure in the appropriate space below:

No measurements were taken during the site visit. Measurements of the river and water quality will be collected during the Remedial Investigation.

_____ Width (ft)

_____ Depth (ft)

_____ Velocity (specify units): _____

_____ Temperature (depth of the water at which the reading was taken _____)

_____ pH

_____ Dissolved oxygen

_____ Salinity

_____ Turbidity (clear, slightly turbid, turbid, opaque) (Secchi disk depth _____)

_____ Other (specify) _____

11. Describe observed color and area of coloration.

12. Is any aquatic vegetation present? ☐ yes ✓ no. If yes, please identify the type of vegetation present, if known.

☐ Emergent ☐ Submergent ☐ Floating

13. Mark the flowing water system on the attached site map.

14. What observations were made at the waterbody regarding the presence and/or absence of benthic macroinvertebrates, fish, birds, mammals, etc.?

V. WETLAND HABITAT CHECKLIST

1. Based on observations and/or available information, are designated or known wetlands definitely present at the site?

   ☐ yes ✓ no - based on field observations.

   Please note the sources of observations and information used (e.g., USGS Topographic Maps, National Wetland Inventory, Federal or State Agency, etc.) to make this determination.

2. Based on the location of the site (e.g., along a waterbody, in a floodplain) and site conditions (e.g., standing water, dark, wet soils; mud cracks; debris line; water marks), are wetland habitats suspected? ☐ yes ✓ no. If yes, proceed with the remainder of the wetland habitat identification checklist.

3. What type(s) of vegetation are present in the wetland?

   ☐ Submergent ☐ Emergent

   ☐ Scrub/Shrub ☐ Wooded

   ☐ Other (specify) _____

4. Provide a general description of the vegetation present in and around the wetland (height, color, etc.). Provide a photograph of the known or suspected wetlands, if available.

5. Is standing water present? ☐ yes ☐ no. If yes, is this water: ☐ fresh ☐ brackish. What is the approximate area of the water (sq. ft.) _____. Please complete questions 4, 11, 12 in Checklist III – Aquatic Habitat – Non-Flowing Systems.

6. Is there evidence of flooding at the site? What observations were noted?

   ☐ Buttressing ☐ Water marks ☐ Mud cracks

   ☐ Debris line ☐ Other (describe below)

7. If known, what is the source of the water in the wetland?

   ☐ Steam/River/Creek/Lake/Pond ☐ Groundwater

   ☐ Flooding ☐ Surface Runoff

8. Is there a discharge from the site to a known or suspected wetland? ☐ yes ☐ no. If yes, please describe.

9. Is there a discharge from the wetland? ☐ yes ☐ no. If yes, to what waterbody is discharge released?

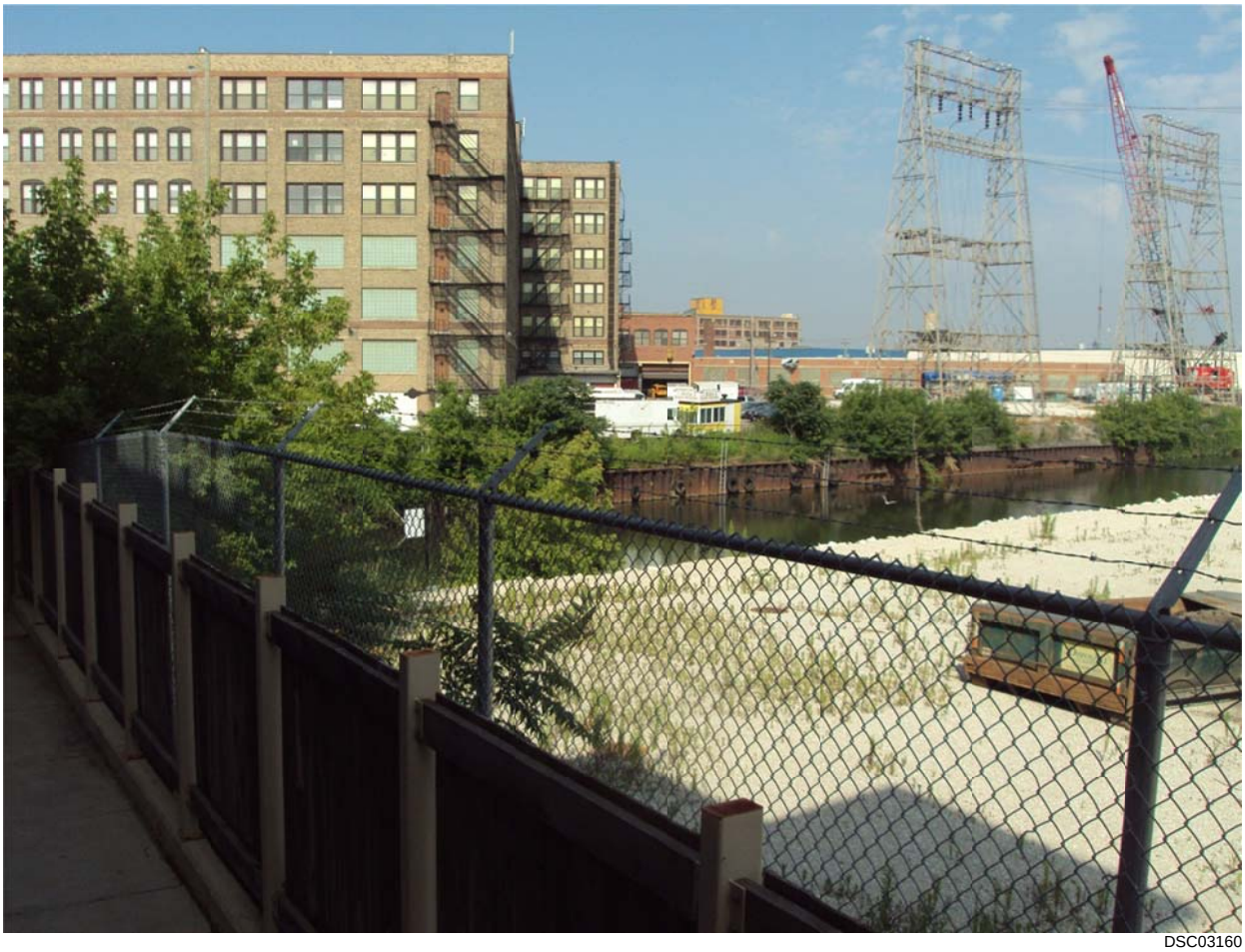
   ☐ Surface Stream/River ☐ Groundwater ☐ Lake/Pond ☐ Marine

10. If a soil sample was collected, describe the appearance of the soil in the wetland area. Circle or write in the best response.

    Color (blue/gray, brown, black, mottled) _____
    Water content (dry, wet, saturated/unsaturated) _____

11. Mark the observed wetland area(s) ion the attached site map.

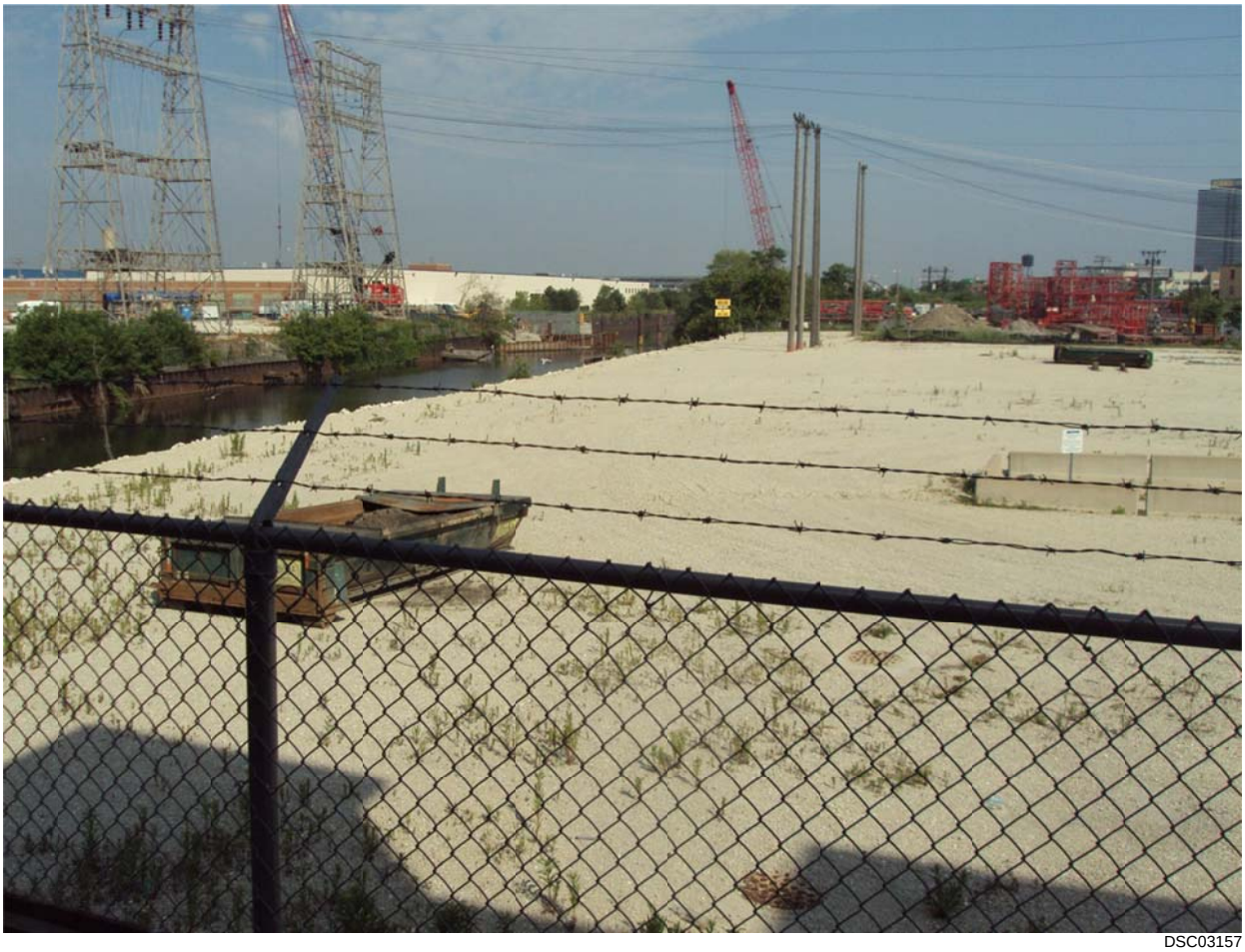
Former North Station Manufactured Gas Plant Site
Site Visit Photographs
July 19, 2011



DSC03160

Photograph 1. Looking west from the neighboring residential property across the south end of the North Station OU to the neighboring commercial property across the North Branch of the Chicago River.

Former North Station Manufactured Gas Plant Site
Site Visit Photographs
July 19, 2011



DSC03157

Photograph 2. Looking northwest from the neighboring residential property across the North Station OU. The LaSalle Chestnut parcels are those covered in gravel. The Division Halsted Parcel is used to store construction equipment.

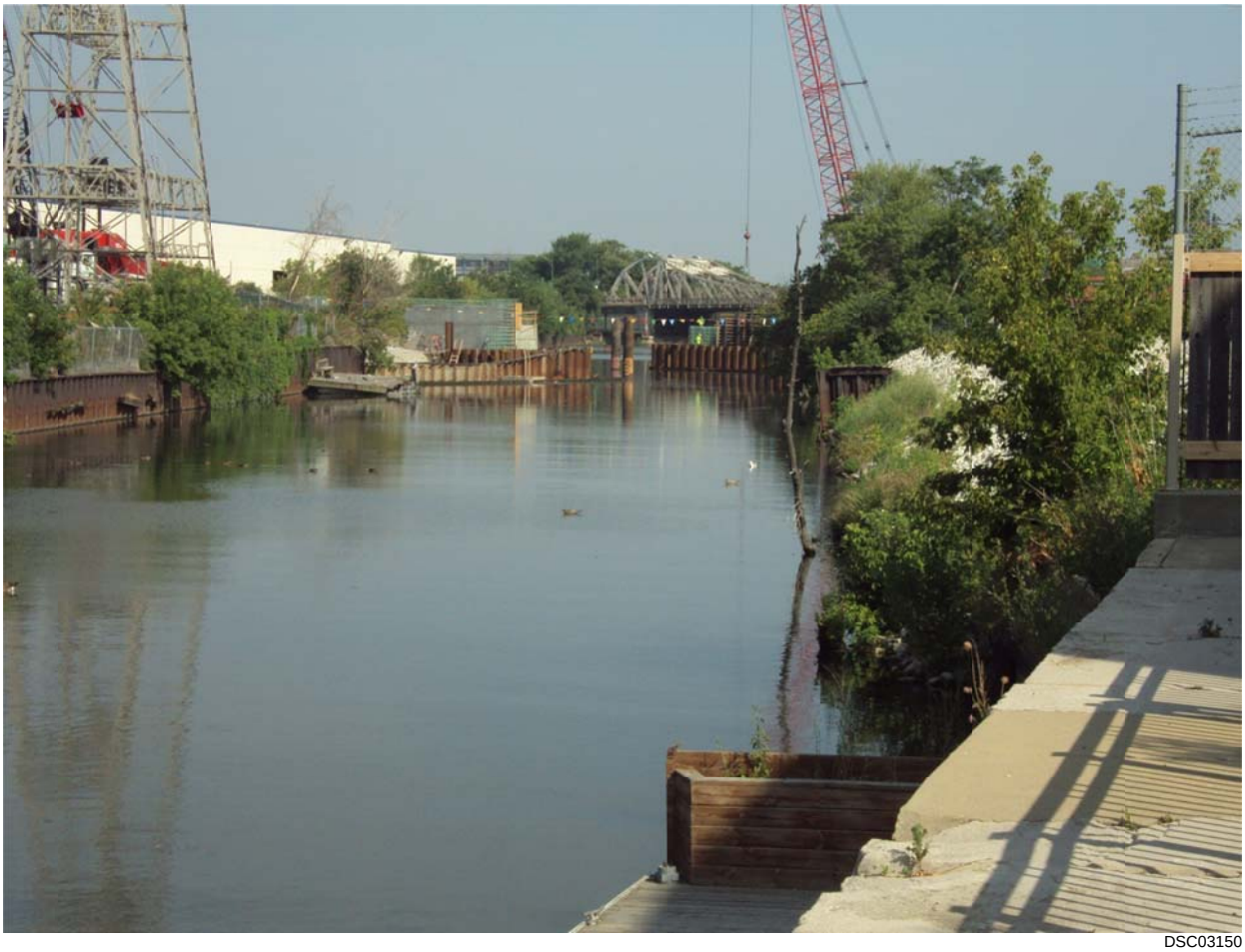
Former North Station Manufactured Gas Plant Site
Site Visit Photographs
July 19, 2011

DSC03158

Photograph 3. Looking north from the neighboring residential property across the North Station OU. The Kingsbury parcel is gravel covered and used to park cars. The ComEd Parcel is an electrical substation.

DSC03156

Photograph 4. Looking upstream along the North Branch of the Chicago River toward the North Station OU from the dockwall located at the adjacent residential property.



DSC03150

Photograph 5. Looking upstream along the North Branch of the Chicago River toward the North Station OU from the dockwall located at the adjacent residential property.

DSC03155

Photograph 6. Looking downstream along the North Branch of the Chicago River at the boat dock located at the residential property adjacent to the North Station OU.

APPENDIX B

SITE-SPECIFIC MODIFICATIONS TO MULTI-SITE DOCUMENTS

APPENDIX B1

SITE-SPECIFIC QUALITY ASSURANCE PROJECT PLAN

B1 SITE-SPECIFIC QUALITY ASSURANCE PROJECT PLAN

This appendix provides site-specific elements as identified in the Integrys Business Solutions, LLC (IBS) Multi-Site Quality Assurance Project Plan (QAPP). Unless specifically noted otherwise, the Multi-Site QAPP will be followed while implementing the Site-Specific Work Plan (SSWP) at the North Station Operable Unit (OU). This appendix references the Multi-Site QAPP sections which may require site-specific elements.

Section 1.1 – Introduction

The Multi-site QAPP addresses all of the activities to be performed at the North Station OU of the North Branch Site.

Section 1.3 – Problem Definition/Background Information (A5)

Soil vapor, related to vapor intrusion into buildings, is considered a media of potential concern for buildings on the OU. The soil vapor sampling approach is provided in Section 6.7 of the Site-Specific Work Plan (SSWP) with additional details on the evaluation in Appendix E of the SSWP.

Section 1.4 – Project/Task Description and Schedule (A6)

Refinement of the Data Quality Objectives (DQO) presented in the Multi-site QAPP are presented in Section 5.1.4 of the SSWP. The following activities described in Section 1.4 of the Final QAPP are not proposed in the SSWP: geophysical investigations to assess limits of waste, etc. The other activities will be performed.

Site-specific tasks to be performed and the sampling rationale are presented in Section 6 of the SSWP.

The project quantitation limits (PQL) presented in the Multi-Site QAPP will be used for the North Station SSWP. There are no additional analytical sampling methods required. Pace Analytical Services is proposed for soil, sediment, and water analyses and STAT Analysis Corporation is proposed for vapor

analyses. Both laboratories are included in the USEPA approved Multi-Site QAPP. A site-specific sampling and analysis summary is presented on Table 2 of the SSWP, which details the media to be sampled and the constituents to be analyzed.

A site-specific schedule for implementing the remedial investigation/feasibility study (RI/FS) activities is presented in Figure 36 and discussed in Section 9 of the SSWP.

Modifications, if necessary, to the Multi-Site Conceptual Site Model (CSM) and the Multi-Site Risk Assessment Framework (RAF) are also discussed in Appendix B4 of the SSWP.

Section 1.5.3 – Step 3 Decision Inputs

As mentioned above, Table 2 summarizes the media to be sampled and the constituents to be analyzed. The PQLs presented in the Multi-Site QAPP will be used for the North Station SSWP. The PQLs will be sufficiently low to compare with the SLs presented in the Multi-Site RAF and Multi-Site RAF Addendum (Exponent 2011). In some instances, the PQL may be above the SL because commercially available techniques cannot achieve detection levels below the SLs. Section 6 of the SSWP describes the sampling devices to be used in accordance with the Multi-site Field Sampling Plan (FSP). Modifications to the FSP are included in Appendix B3.

Section 1.5.3.1 – Screening Level Ecological Risk Assessment (SLERA)

Guidance documents to be used to evaluate ecological risk are described in the Multi-Site RAF and the approach is further discussed in Section 4 of the SSWP.

Section 1.5.3.2 – Human Health Risk Assessment (HHRA)

Guidance documents to be used to evaluate human health risks are described in the Multi-site RAF and the approach is further discussed in Section 4 of the SSWP.

Section 1.5.4 – Step 4 Investigation Boundaries

Figure 2 of the SSWP depicts the site boundaries, zoning and ownership. Figures 34 and 35 provide proposed sampling locations.

Sample volumes required for laboratory and toxicity testing are provided on Table 2 of the SSWP.

As mentioned above, the sampling rationale is presented in Section 6 of the SSWP.

Section 1.5.8 Measurement Performance Criteria

The laboratories selected to perform the analysis are discussed in Section 6.10 of the SSWP and include Pace Analytical Services for soil/sediment and water samples and STAT Analysis Corporation for vapor samples. Both laboratories are included in the USEPA-approved Multi-Site QAPP. Modifications, if any, will be provided to USEPA for review and approval in accordance with the Administrative Order on Consent/Statement of Work (AOC/SOW).

Section 2.1.1 Schedule

A site-specific schedule for implementing the remedial investigation/feasibility study (RI/FS) activities is presented in Figure 36 and discussed in Section 9 of the SSWP.

Section 2.1.2 Sampling Design Rationale

Table 2 summarizes the media to be sampled and the constituents to be analyzed. Appendix D and E3 of the SSWP provide additional discussion of the constituents to be analyzed.

Section 2.3.1.3 Sample Container, Volume, Preservation and Holding Time

Table 2 summarizes the sample containers, volume, preservation and holding times for the media to be sampled and the constituents to be analyzed.

Section 2.4 Analytical Methods Requirements (B4)

Table 2 summarizes the parameters to be analyzed.

APPENDIX B2

SITE-SPECIFIC HEALTH AND SAFETY PLAN

SITE-SPECIFIC HEALTH AND SAFETY PLAN

FORMER MANUFACTURED GAS PLANT SITE
NORTH STATION OPERABLE UNIT OF THE NORTH BRANCH SITE
W. HOBBIE STREET AND N. KINGSBURY STREET
Chicago, IL 60610

Prepared by:

Natural Resource Technology, Inc.
23713 W. Paul Road, Suite D
Pewaukee, WI 53072

July 15, 2011

Project No:
2034

Brian G. Hennings, PG
Hydrogeologist

Sarah L. Meyer
Senior Scientist / Project Manager

NATURAL RESOURCE TECHNOLOGY
SITE SPECIFIC HEALTH AND SAFETY PLAN SUMMARY

Prior to initiating site-specific field activities, the following information will be provided to USEPA and to each field staff member within the Site-Specific Work Plan (SSWP). A copy of this Health and Safety Plan (HASP) will be maintained on site during field activities and updated as determined necessary by the Project Manger.

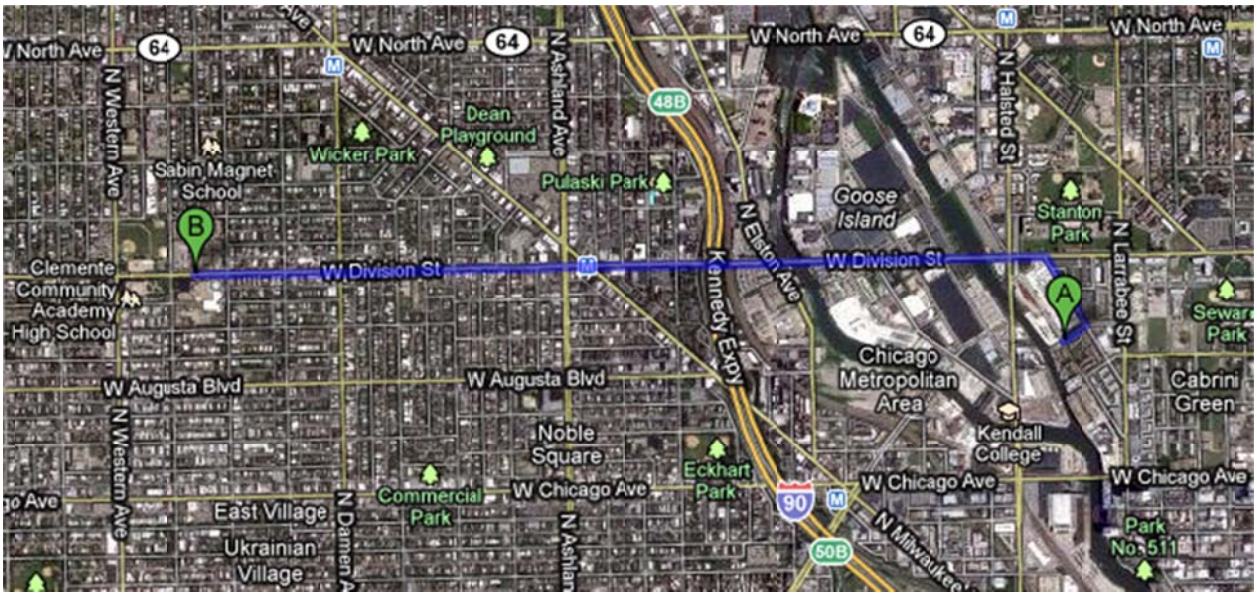
Site Address: Hobbie and Kingsbury Streets, Chicago, IL 60610

Major Cross Roads: Division Street and Halstead Street

Hospital Address
Saint Mary Campus at 2233 West Division Street (Division and Leavitt)

Directions to Hospital from Site (see map below):

- Start at site (A-Corner of West HOBBIE Street and North KINGSBURY Street)
- Head northeast on West HOBBIE Street toward North CROSBY Street (338 ft)
- Take the 1st left onto North Crosby Street (0.2 mi)
- West on West DIVISION Street (1.8 miles)
- Arrive at hospital (B-2233 WEST DIVISION St Chicago, IL 60622)



Description of Site (See map on next page):

The former MGP operations encompassed an area totaling approximately 7.5 acres and portions of the North Branch of the Chicago River (SSWP, Figure 2). The MGP structures occurred on an approximately 5.5 acre parcel which is currently owned by Commonwealth Edison (ComEd). This parcel is an electrical substation with associated buildings and transmission towers. Two adjacent properties immediately to the southwest, between Kingsbury Street and the North Branch of the Chicago River were part of the MGP operations but were utilized only for coal storage. One of the properties, referred to as the LaSalle-Chestnut parcel, is approximately 1.5 acres in size. The second property is referred to herein as the Division Halsted parcel of which of only the southern approximately 0.5 acres was used for coal storage. This parcel occurs immediately adjacent to and northwest of the LaSalle-Chestnut property. The North Station Site also includes the portion of vacated Kingsbury Street which adjoins the ComEd, LaSalle-Chestnut and Division Halsted parcels.

Activity(s):

Surface and subsurface soil characterization will be achieved by completing soil borings by the use of hydraulic direct push boring technology (e.g., Geoprobe®), hollow stem auger, vacuum excavation and/or by hand-driven soil augers. If bedrock drilling is required air-hammer, wire-line coring, or sonic drilling methods may be used. The area is expected to contain urban contamination typical of a developed industrialized area and impacts related to the former MGP site. Drilling will be done by a qualified contractor. Hand-driven soil auger borings may be completed by NRT. Drilling/sampling cuttings and decontamination water from the activities will be containerized and disposal will be coordinated by NRT.

The North Branch of the Chicago River will be characterized by collecting surface water and sediment samples. Sampling will be conducted using barge-mounted hydraulic direct push boring technology (e.g., Geoprobe®), or hollow-stem auger drill equipped with 3-inch diameter spoons. Drilling will be done by a qualified contractor who will hand the spoons and samples to NRT. NRT will not attempt to handle any drilling equipment. Additional sampling will be conducted from a pontoon boat using a check-valve push core sampler. Samples will be shipped to labs via local or overnight courier for analysis of COPCs and potentially geotechnical parameters.

Soil vapor and subslab vapor will be characterized by construction of soil vapor probes in boreholes created using one of the soil coring methods described above. Vapor probes will be sampled by NRT. Leak testing will be completed using a helium shroud. Samples will be collected in vacuum canisters and submitted to an analytical laboratory using courier service.

Health/Safety Hazards on Site:

Chemical	Media	Maximum Concentration	Routes of Exposure
Volatile Organic Compounds	Soil, Sediment, Vapor, Water	Potential for tar, high levels of contaminants	Inhalation, ingestion, skin or eye contact
Semi-Volatile Organic Compounds	Soil, Sediment, Vapor, Water	Potential for tar, high levels of contaminants	Inhalation, ingestion, skin or eye contact
Metals	Soil, Sediment, Water	Moderate	Inhalation, ingestion, skin or eye contact
Cyanide	Soil, Sediment, Water	Moderate	Inhalation, ingestion, skin or eye contact
Polychlorinated biphenyls (PCBs)	Soil, Sediment, Water	Unknown/Low, not previously identified on site	Inhalation, ingestion, skin or eye contact

The safety coordinator/emergency coordinator will be the NRT staff personnel supervising the field investigation/work.

Protective Equipment/Instruments:

In general, personal protective equipment (PPE) will be used as specified on Table 1 for the anticipated project tasks. The project manager may require additional PPE based on field conditions or additional data collection.

Air Monitoring:

In general, a photoionization detector (PID) will be used to monitor air quality in the work zone and breathing zone during site investigation activities on an as-needed basis, to be determined by the on-site lead. Potential tasks requiring use of the PID are listed in Table 1. Use of the PID may be periodic during soil boring and sampling. Specific VOC sources on site include the potential for tar and tar-like material at depth.

Actions levels for the PID are listed below and discussed in more detail in Section 7.3. The VOC action levels include the following:

- Occurs when a reading of 50 ppm is sustained on PID it is held at a constant height either in the excavation or the breathing zone. (Sustained readings last more than 30 seconds and the meter either continues to climb or remains relatively stable. Wildly fluctuating readings require a calibration check).

- Sustained readings of 50 ppm require use of either full-face or half-face respirators utilizing Organic Vapor cartridge filters.

- Air quality monitoring continues to ensure that PID readings do not exceed sustained readings of 500 ppm.

- If the 500-ppm action level is achieved, all activities on the site will immediately stop. The NRT PM will be contacted prior to taking any further action on the site.

Safety Equipment:

Fire extinguisher and first aid kit in NRT field vehicles. Fire extinguisher, first aid kit, life vests, ropes, and poles on NRT field boats.

EMERGENCY CONTACT LIST

Client Contact:	Naren Prasad, office	(312) 240-4569
Fire Dept:	Chicago Fire Department	(312) 664-6450
Police:	Chicago Police Department – 18th District	(312) 742-5870
Sheriff:	Cook County Sheriff's Police	(708) 865-4700
Local Utility	DIGGER-Chicago Utility Alert Network	(312) 744-7000
Local Water Co.	Water Management	(312) 747-8019
NRT:	Main Office	(262) 523-9000
Ambulance or Emergency Medical	911	911
Lead-Contractor:	Sarah Meyer, Natural Resource Technology, Inc., cellular	(773) 339-3134
Hospital:	Saint Mary Medical Center 2233 West Division Street, Chicago, IL 60622	(312) 770-2000 Non-emergency
Field Staff Emergency Contact	Sarah Meyer (Project Manager), cellular	(773) 339-3134

Table 1. Summary of PPE By Sampling Activities

PPE Required	Site Reconnaissance/Field Mobilization	Drilling (monitoring wells/bore holes)	Monitoring Well Development and Conductivity Testing	Groundwater Levels and Sampling	Soil Sampling (heavy equipment or drill rig)	Soil Sampling (hand augers or shovels)	Vapor sampling	Test Pit Excavation/Trenching	Surface Water Sampling (from land or shallow wading)	Surface Water Sampling (water craft)	Sediment Sampling (shallow wading)	Sediment Sampling (water craft)	Subsurface structure inspection (from surface)
Steel-Toed Boots (Rubber)		Av	Av	Av	Av	Av		Av	Av	Av	Av	Av	Av
Steel-Toed Boots (Leather)	X	X	X	X	X	X	X	X	X	X	Av	X	X
Hard Hat		X			X			X				X	X
Safety Glasses/Goggles	X	X	X	X	X	X	X	X	X	X	X	X	X
Gloves-Inner (Nitrile)	Av	X	X	X	X	X	X	X	X	X	X	X	Av
Gloves-Outer (Nitrile)		X	X	X	X	X	X	X	X	X	X	X	
Orange Vest	X	X	X	X	X	X	X	X	X	X	X	X	X
Life Vest									X	X	X	X	
Tyvek Coverall		Av			Av	Av	Av	Av			Av	Av	
Saranex Coverall											Av	Av	
Half-Face Respirator					Av	Av	Av	Av					
Respirator Cartridge (Hepa with Org. Vapor)					Av	Av	Av	Av					
Photoionization Detector (PID)		x			x	x	x	x					X
Combustible Gas Meter (CGM)													X
Other													

Key: X = PPE Required
Av = Have available at work site
Glove types may be altered based on field conditions to include Vinyl, Neoprene, and/or Latex

FIELD HEALTH & SAFETY BRIEFING

NRT Project # 2034 NRT Task # _____

I HEREBY CERTIFY THAT I HAVE READ AND UNDERSTOOD ALL HEALTH AND SAFETY PROCEDURES AS STATED HEREIN:

Name and Affiliation (printed)	Signature	Date

H & S plan was received from subcontracting company.

☐ YES ☐ NO ☐ Not Applicable

H & S training documentation was received from subcontracting company

☐ YES ☐ NO ☐ Not Applicable

This page should be copied after it has been signed and put into the project file.

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FIGURES

Figure 1 Site Location Map
Figure 2 Site Layout

APPENDICES

Appendix A: MSDSs

1 INTRODUCTION

1.1 Purpose and Scope

This document describes the health and safety procedures and requirements for the installation of borings/wells, test pit excavations, sampling of soil (surface and subsurface), groundwater, soil vapor, surface water and sediment and subsurface structure inspection (from ground surface). This document is intended to serve as a Multi-Site Health and Safety Plan (HASP) to ensure that the field work performed by NRT is done in compliance with applicable federal occupational safety and health regulations. All subcontractors shall be made aware of the requirements of this plan; however, subcontractors are required to have their own plan for the health and safety of their own employees and for following all applicable federal, state, and local regulations.

In compliance with HAZWOPER, a comprehensive work plan will be developed for each site to evaluate the logistics and resources needed to reach work objectives for site operations. The work plan will identify cleanup activities, methods for accomplishing the objectives (sampling plans), and normal operating procedures. Comprehensive site specific work plans will be available on location at each site along with a Multi-Site Field Sampling Quality Assurance Project Plan (QAPP) and Site-Specific Work Plan.

1.2 Health and Safety Plan Modification Procedures

Due to varying site conditions or the finding of unanticipated hazards, it may be necessary to revise the health and safety plan. Necessary plan changes that call for more stringent procedures or a higher level of personal protective equipment (PPE) may be made at any time by the Project Manager (PM) or Task Leader in cooperation with the Project Health and Safety Officer (PHSO). The PM should be notified at the soonest available opportunity.

Plan changes that would make safety procedures or PPE requirements less stringent may be made only upon approval of the PM after consultation with the Corporate Director of Health and

Safety (CDHS). Plan changes must always be put in writing and communicated to all field personnel.

2 KEY PERSONNEL/IDENTIFICATION OF H&S PERSONNEL

2.1 Key Personnel

Responsibilities for health and safety compliance issues associated with hazardous waste operations are primarily vested in the project organization, with support from appropriate health and safety professionals on NRT's technical and administrative staffs.

2.2 Site-Specific Health and Safety Personnel and Organizational Responsibility

2.2.1 Corporate Director of Health and Safety

The Corporate Director of Health and Safety (CDHS) acts as a technical resource to all NRT offices on health and safety matters. This person is responsible for ensuring that all NRT health and safety programs comply with applicable federal, state, and local statutes for safety and health protection; executive orders; operating orders; permits and regulations; and company policies and procedures. The CDHS is also responsible for review and approval of all site-specific Health and Safety Plans, serves in a consultation capacity to the technical staff on health and safety-related issues, and has the authority to conduct health and safety audits.

2.2.2 Project Manager

The Project Manager (PM) is accountable for health and safety compliance on his or her projects. The PM is responsible for the technical and financial execution of the project, and has the authority to commit resources, adopt program policies and procedures, and approve expenditures and subcontracts. The PM will ensure that adequate resources are budgeted and available to implement a sound health and safety program and that appropriate technical resources are brought in to support the health and safety needs of the project. The PM will ensure that health and safety is a high priority in planning fieldwork and or lab studies, and that

adequate resources are available to develop and implement an appropriate project-specific health and safety plan.

2.2.3 Project Health and Safety Officer

The Project Health and Safety Officer (PHSO) is responsible for developing and implementing the project- or site-specific Health and Safety Plan. In the event a PHSO has not been identified for a specific project, the PM will assume those responsibilities. The PM is ultimately responsible for health and safety for the project. It is the responsibility of the PM to report any unsafe conditions reported by the project staff to the CDHS and to work cooperatively to mitigate unsafe conditions. The PHSO will also ensure compliance with health and safety requirements presented in this Plan. The PM will serve as the PHSO unless site-specific hazards are identified warranting assignment of a PHSO to the project. To meet these responsibilities, the PM/PHSO may:

- Act as a health and safety consultant to the project field staff;
- Provide site-specific training to all staff assigned to work at the site;
- Review and confirm any changes in personal protective clothing or respiratory protection requirements;
- Require the specific health and safety precautions be taken before personnel enter a site;
- Restrict access to the site or a portion thereof;
- Perform necessary personnel monitoring;
- Stop work when the health or safety of project personnel are jeopardized and order the immediate evacuation of personnel from any area of the site;
- Require personnel to obtain immediate medical attention if warranted;
- Provide health and safety briefings to all site visitors; and
- Enforce the requirements stated in the Corporate Health and Safety Manual and the project- or site-specific Health and Safety Plan.

2.2.4 Field Team Members

All NRT personnel must know, understand and comply with the requirements of this Plan developed for their projects. Field personnel will:

- Read and understand all applicable health and safety plans;
- Perform their work safely;
- Be aware of and alert for signs and symptoms of work-related injuries and illnesses; and
- Promptly report any unsafe conditions that may occur on site to the PHSO, PM, and/or CDHS.

2.2.5 Subcontractors

Subcontractors have primary responsibility for the health and safety of their own employees. However, NRT is required by OSHA standards (e.g., 29 CFR 1910.120) to provide information to its subcontractors on known or potential workplace hazards, as well as the methods proposed to manage the identified hazards.

It is currently OSHA policy to issue citations to prime contractors in the event that their subcontractor is found to be out of compliance with regulatory requirements. NRT may incur civil penalties as a result of non-compliance with regulatory requirements by its subcontractors and/or injuries or illnesses incurred by the subcontractor's staff. Personal injury suits have been successfully brought against prime contractors in instances where a subcontractor's employee has demonstrated that the lack of health and safety oversight on the part of a prime contractor played a role in his or her sustaining an injury or illness.

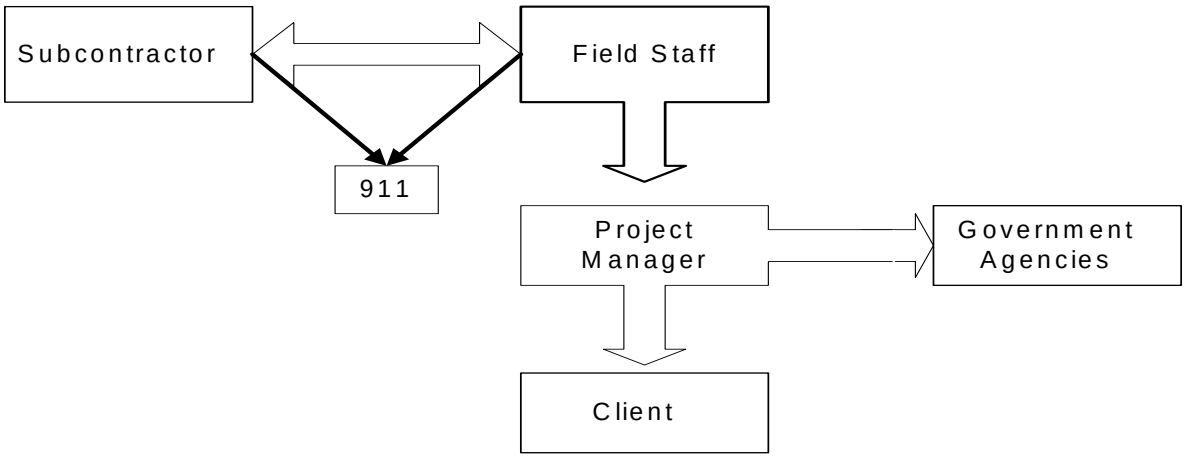
NRT intends to manage its subcontractors to protect the health and well being of NRT staff. NRT's objective is to manage subcontractors in a way that limits NRT's and our client's liabilities related to subcontractor performance, including management of health and safety issues. To achieve this objective, a minimum level of subcontractor surveillance, with respect to health and safety issues is required.

When required by NRT, the subcontractor must review project-specific health and safety information and hazards, and develop and implement a health and safety plan. This plan must comply with all applicable health and safety regulations and any project-specific requirements that NRT has specified. The subcontractor must provide NRT with a copy of this plan before the start of work. NRT acceptance of the subcontractor's plan does not mean that NRT concurs with the adequacy of the plan for protection of the health and safety of the subcontractor's employees. That responsibility rests solely with the subcontractor. NRT's review of subcontractor health and safety plans will be for the purposes of: 1) assessing potential health and safety impacts to NRT personnel and 2) meeting NRT legal responsibilities as a prime contractor. Any deficiencies in the subcontractor's plan or inconsistencies in proposed work practices between NRT and its subcontractor should be identified. If appropriate, these deficiencies or differences should be resolved before the work begins.

2.3 Communication

Field staff and subcontractors are both permitted to call 911 in an emergency situation. Emergency numbers will be provided in the Site-Specific Health and Safety Plan Summary to be included as an appendix to the Site-Specific Work Plan. As part of preparing the Site-Specific Health and Safety Plan Summary, 911 services will be verified for each site location. Assuming the PM is not on-site, the field staff should contact the PM as soon as possible regarding the on-site situation. It is then up to the discretion of the PM to contact the Client or Government Agencies if the on-site situation requires. The following flow chart is a depiction of a typical on-site communication procedure (assuming the PM is not on-site).

Communication Procedure



3 TASK/OPERATION SAFETY AND HEALTH RISK ANALYSIS

3.1 Historical Overview of Site

A historical overview of the site along with details of the project description is provided in the project Work Plan. Further, the Quality Assurance Project Plan (QAPP) presents the organization, objectives, planned activities, and specific Quality Assurance/Quality Control (QA/QC) procedures.

Specific protocols for sampling, sample handling and storage, chain-of-custody, and laboratory and field analyses to be performed are described in NRT's SOPs included in the Multi-Site QAPP. All QA/QC procedures are structured in accordance with applicable technical standards, U.S. EPA's requirements, regulations, guidance, and technical standards.

3.2 Risk Analysis-General

All personnel in the vicinity of the drilling, excavation, and sampling operations are not only subject to the hazards of direct exposure, but also to dangers posed by machinery operation. In addition, stresses due to working in protective clothing will be encountered. Physical, chemical, and biological hazards are present at most job sites.

3.2.1 Heat/Cold Stress

Temperature extremes, wet working conditions, and PPE can all combine to cause injury and illness to field workers. In general, high temperatures and/or impermeable PPE can induce heat stress. Cold stress can be induced by low temperatures and/or wet skin or clothing.

PRECAUTIONS

Heat Stress: Wear thin cotton clothing under Tyvek™ suits; have thirst liquids available; and, stop work if heat exhaustion occurs (i.e. light headedness, profuse sweating).

Cold Stress: Dress in layers and regulate clothing to activity levels; wear plenty of layer clothing (so layers can be added or removed); cover exposed skin when windy; glove liners can keep hands warm but reduce dexterity; use face masks and helmet liners to keep head warm and, stop work if conditions get too cold.

SYMPTOMS

Heat Stress: Profuse sweating, weakness, rapid pulse, dizziness, nausea, and headache. If heat stroke occurs, the skin will be hot, dry and flushed.

Cold Stress: Involuntary shivering, speech difficulty, loss of manual dexterity, and memory lapse. The most severe localized form of cold stress, frostbite, causes the skin to become numb, pale, hard, and cold.

FIRST AID MEASURES

Heat Stress: Move the person to a shaded, cool area. Have them drink large quantities of fluids. In the case of heat stroke, seek medical attention immediately.

Cold Stress: Move the person to a heated, sheltered area. Immerse exposed body parts in warm (104-130 ^{o}F) water. If exposed skin is numb, do not rub it. If frostbite is suspected, seek medical attention as soon as possible.

3.2.2 Slips, Trips, and Falls

The most common hazards that will be encountered will be slips, trips, and falls. Common sense will be used to avoid these hazards. When working on slippery surfaces, tasks will be planned to decrease the risk of slipping. Slippery surfaces will be avoided, work and travel will not be hurried, and good housekeeping will be maintained. All personnel must vigilantly observe where they are working and walking to avoid slips, trips, and falls.

3.2.3 Vehicular Traffic

Another common hazard that will be encountered at many sites will be vehicle traffic, including cars, trucks, drilling rigs and heavy machinery. When it is necessary to move a vehicle, all site drivers must be mindful that pedestrians are present on site. If appropriate, site personnel on foot may guide site drivers while moving vehicles to alert and protect non-site personnel. Site personnel on foot must avoid standing in blind spots or in high traffic areas, be aware of vehicle locations, and make eye contact with site drivers if crossing the path of vehicles is necessary. All site personnel on foot must vigilantly observe where they are working and walking to avoid being struck by vehicles which, for one reason or another, are moving. Finally, when working in high traffic areas (i.e., on the edge or in the middle of city streets or heavily used parking areas) site personnel are required to set up traffic cones and wear orange traffic safety vests to alert drivers to their presence.

Work performed in rail yards or along railroad tracks poses an additional hazard. Numerous incidents have occurred when working between or alongside rail lines and have resulted in serious injury or death. Therefore, the following rules must be followed when working near rail lines:

- Never walk or step on a railroad track. The tracks can be slick and injury due to slipping off a track is possible.
- Never run over tracks - Always Walk. Tripping injuries can occur when running over the tracks which can result in serious head injuries.
- Never stand between the tracks. When necessary, walk across the railroad tracks and stand to one side or the other of a rail line.
- Always wear a hard hat, eye protection, steel-toed boots and an orange reflective vest for personal protection.

In addition to these rules, whenever work is done near railroad tracks or in a railroad right-of-way, the railroad company must be contacted and a flagman requested to monitor work activities. No work will be done without a railroad flagman being present unless the railroad company expressly permits it.

3.2.4 Hunting Season

It is possible field activities will be conducted during hunting seasons and may pose a risk to site workers. The hunting season dates for Wisconsin will be reviewed prior to conducting field activities in non-urban areas. Hunting season dates are provided at:

http://www.dnr.state.wi.us/org/land/wildlife/hunt/seasdate.htm

Site workers will wear a minimum of at least 50% of the outer clothing above the waist in 100% blaze orange (faded blaze orange is not acceptable) to alert potential hunters to their presence. If site work is performed in densely vegetated locations, site personnel may post signs along access locations to indicate their presence.

Hunting season concerns will not be an issue for work being done in the Chicago metropolitan area.

3.2.5 Exposure to Excessive Noise

Overexposure to noise can result in hearing loss. If it is difficult to hear normal speech when the speaker is 3 to 4 feet from the listener, and that condition is present for more than four hours a day, it will be assumed that the noise level exceeds 85 dBA and appropriate hearing protection will be used. The disposable "ear plug" type hearing protectors are recommended.

3.2.6 Chemical Hazards

PPE requirements are stated in Personnel Protection Section 5 of this Plan. Material Safety Data Sheets (MSDSs) for suspected contaminants are contained in Appendix A.

3.2.7 Biological Hazards

During warm weather months, potential biological hazards include venomous insects, snakebites, and poisonous plants. Appropriate safety measures, such as the use of insect repellent and probing of possible nesting areas, will be taken to prevent exposure to biological hazards. Long sleeves and pants will provide protection from contact with poisonous plants.

3.2.8 Thunderstorms and Rain

Drilling/excavation and sampling activities during electrical storms poses a hazard of electrocution by lightning strike, and adverse working conditions, as well as high winds tipping the drill rig. All drilling/excavation and sampling activities will stop and the drilling rig mast will be lowered at the approach of a thunderstorm. Drilling activities during rainstorms can cause not only slippery conditions but also excess friction on cathead pulleys. This can cause dangerous conditions during drive sampling operations. Therefore all drive sampling operations will cease and, depending on the PHSO's assessment, drilling may be halted.

3.3 Risk Analysis-Task-by-Task

Table 1. Anticipated Task Hazards

	Hazards												
					Physical								
	Chemical	Biological	Explosive	General Safety	Heat	Cold	Traffic	Noise	Slip, Trips, Falls	Heavy Equipment	Underground utilities	Overhead Power Lines	Trench/Excavation
Site reconnaissance/field mobilization		X	X	X	X	X	X	X	X	X	X	X	
Well and bore hole drilling	X	X	X	X	X	X	X	X	X	X	X	X	
Monitoring well development	X	X		X	X	X	X		X				
Groundwater level measurements	X	X		X	X	X	X		X				
Groundwater, soil, and vapor sampling and construction of vapor probes (after hole is drilled)	X	X		X	X	X	X		X				
Test pits and excavation	X	X	X	X	X	X	X	X	X	X	X	X	X
Sediment and surface water sampling	X	X		X	X	X	X	X	X	X	X	X	
Sampling through ice	X	X		X		X	X	X	X	X		X	

3.3.1 Well and Bore Hole Drilling

In addition to the possibility of contact with the above listed chemicals, physical hazards associated with well and bore hole drilling include:

- Snapping cables;
- Brush and equipment fires;
- Being hit by equipment;
- Being caught in rotating tools;
- Falling objects;
- Exposure to excessive noise; and
- Contact with energized electrical lines.

3.3.2 Air Rotary Drilling

This type of drilling, in addition to the above listed hazards, may also expose field personnel to blowing dust and high-pressure airlines.

3.3.3 Groundwater, Seep, Soil, and Pipe Sampling

Collection of these samples presents the hazard of inhalation exposure to and skin contact with the substances listed in Appendix A.

3.3.4 Drilling/Excavation near Overhead Electrical Lines

Drilling or excavation activities near overhead electrical lines present a serious electrocution hazard. Safe work distance must be maintained. This distance is a function of the humidity and the voltage present. Should work in the proximity of overhead lines be required, the minimum clearance will be determined based on OSHA standards.

3.3.5 Drilling/Excavation near Underground Electrical/Utility Lines

Buried electrical/utility lines present a hidden danger while drilling/excavating. The subcontractor will be responsible for contacting the local underground utility locator service (i.e. Diggers Hotline in Wisconsin); however, it is the responsibility of the NRT PM or PHSO to ensure that the subcontractor has contacted the appropriate locator service to ensure that site activities can be completed in accordance with the schedule. The locator service will mark all underground lines to ensure safe working conditions. Drilling/excavation will not occur within three feet of any marked underground line.

3.3.6 Test Pits and Excavation

Test pits and excavations pose a serious threat of injury resulting from falls or excavation wall collapses. During excavation or digging activities an exclusion work zone will be established around excavating machinery. All bystanders and on-lookers will be prohibited from entering this work zone while the excavating machinery is in operation. The work zone will be large enough so that the excavating machinery (i.e. trackhoe, etc.) can rotate 360° without extending out of the work zone. After the excavation is completed it should either be backfilled immediately or the entire excavation will be encircled with a physical barrier (i.e. barricades, orange excavation fencing, etc.) which will limit access to the excavation and decrease the likelihood of injury resulting from falls. Any excavation greater than four feet deep will NOT be entered unless the walls of the excavation have been reinforced to prevent wall collapse. Entry into any excavation greater than four feet deep will constitute a confined space entry procedure. Therefore, no excavation entrance is allowed.

A PID will be used to monitor air quality in the breathing zone of the work area for VOC vapor levels and in an excavation (See Section 7 of this plan). Prior to Contractor Personnel entering any excavations to install piping or any other equipment, the PID will be lowered into the excavation to determine air quality in the excavation. Confined spaces will not be entered.

3.3.7 Operations on Surface Waters

The procedures specified in this subsection are designed to protect NRT staff when conducting work activities involving water craft vessels on surface waters. Governmental laws and regulations regarding onshore waters are under the jurisdiction of the Unites States Coast Guard (USCG-Great Lakes) and the Wisconsin Department of Natural Resources (WDNR-Wisconsin inland waters). When conducting any surface water work activities out of state (i.e. other than Wisconsin), that state regulatory agency and its regulations will be adhered to.

Always Work In Pairs – Never Conduct Work Activities Alone.

Due to the location and manner in which work activities are conducted, the threat of falling into the water is very high. Carry retrieval equipment including:

- 50 foot of line at least 3/8 inch diameter, and
- Two - six (6) foot 2" x 4"s.

3.3.7.1 Scope and Applicability

The procedures specified in this subsection apply to all work activities involving surface waters (including sediment sampling). The highest ranking NRT staff member (i.e. Project Manager, Field Task Leader) at the work site is responsible for implementing this plan. The work activities will not be initiated prior to receiving approval from the PM.

- Work activities can be conducted in "open water" or "ice" conditions; and
- Each NRT staff person at the site is responsible for following these procedures.

3.3.7.2 Water Craft

The following procedures will be observed when NRT staff conducts work activities in "open water" conditions in a water craft vessels (including drill rigs mounted on barges):

- Work will not be initiated prior to meeting approval from the PM;

- All work activities conducted on surface waters will be conducted in accordance with the requirements of the USCG and WDNR (or other appropriate state agency);
- Personal Flotation Devices (PFD) that are USCG approved must be worn at all times when on surface waters. One adult size PFD (wearable style) for every person on the water craft is required;
- A minimum of two (2) PFDs must be on board on the water craft at all times on Wisconsin waters;
- Have on board a "throwable" flotation device w/attached line;
- Distribute weight evenly across the beam of the watercraft;
- Only allow one person to stand at a time in a small watercraft vessel;
- Do not exceed manufacture's capacity plate load limits;
- Attach a lanyard or safety line which can be tied to the sampling personnel when water surface conditions are rough. This will enable easier retrieval of the person should he/she fall over the side of the water craft;
- Check running condition of the outboard motor prior to launching (i.e. ample supply of fuel/oil mix, fuel line in good condition, integrity of the propeller, EXTRA SHEER PINS);
- Equipment to have on board include oars, anchor w/line (100 foot minimum line on inland waters) and mooring lines of adequate length;
- Wear work gloves when using equipment that could injure hands;
- Wear hard hat if overhead hazards exist (e.g. A-Frame, use of long coring devices);
- Secure overboard equipment to vessel; and
- Use proper lifting techniques when retrieving heavy equipment.

3.3.7.3 Shallow Water

Site-Specific Work Plan and the site reconnaissance will evaluate the best approach to sampling in shallow water. If wading is necessary, work activities in shallow water along the shore line shall consider the following hazards:

- Use waders to minimize exposure to water, sediment contaminant exposure and heat loss;

- Proceed carefully – water currents and falling can cause the waders to fill creating a very serious condition. In addition to wearing a PFD, a safety line should be tethered to the person walking in water currents;
- Fatigue can occur more rapidly from walking through the water.

3.3.7.4 Sampling Through Ice

Collection of samples through frozen rivers/lakes presents the difficulties of working on ice. All precautions for slips, trips and falls will be observed. Ice thickness will be at a minimum of 9 inches thick before work activities will commence.

The following procedures will be observed when NRT staff conducts work activities on "ice" conditions:

- Work activities will not be initiated prior to meeting approval from the Environmental Health & Safety Manager (EHSM);
- Know the ice (i.e. thickness) and proceed with extreme caution. Ice thickness at a minimum should be 18 to 24 inches (when conducting drilling operations) and inspected for integrity. Check ice thickness regularly when traversing across ice to assure adequate support exists. Be especially cautious when approaching pressure cracks, areas of open water or areas of rivers where water velocity may be higher;
- Wear PFDs at all times;
- Warm weather causes ice thinning and potential for slipping (drilling holes on thinning ice can cause flooding of ice surface and can accelerate ice thinning and breakage);
- Equipment may be required to be hauled between work stations (use sleds); and
- Fatigue can occur from walking and drilling holes.

Based on water currents, water temperature and the amount of clothing worn by NRT staff, the threat of being swept downstream or drowning is possible. Extreme caution must be used when conducting these type of work activities. If a NRT staff employee should fall into the water, the employee will be retrieved and all warranted precautions shall be taken to ensure the safety and well being of that individual. All work activities will be immediately suspended and the person brought to shore. All wet clothing shall be removed and the person shall be dried and dressed

in a set of dry clothes. If the possibility of hypothermia exists, seek medical attention immediately.

Persons sampling contaminated or potentially contaminated materials should wear the same PPE as listed for monitoring well sampling. The required PPE will be carried along on the sediment sampling water craft. PPE can add to heat stress during warm conditions and can cause decreased mobility dexterity.

3.3.7.5 Subcontractors

It is the responsibility of the PM to require any and all subcontractors assisting in the work activities, to adhere to state and federal governmental laws and regulations related to onshore and inland waters. Any refusal on behalf of the subcontractor will mandate shutdown of the project.

4 PERSONNEL TRAINING REQUIREMENTS

4.1 General

All NRT and subcontractor employees performing field work on this project are required to have appropriate safety training as specified in the OSHA Standards, particularly the HAZWOPER Standard 29CFR1910.120. NRT personnel performing fieldwork on this project meet the necessary general training requirements. Subcontractors are responsible for supplying NRT's PM with written statements certifying that all of their project personnel meet the necessary general training requirements.

4.2 Site-Specific

Site-specific hazard and hazard control information is contained in this health and safety plan. All NRT personnel will be provided with a copy of this plan prior to the beginning of fieldwork. Each person will be required to "sign off" that they have read, understood, and will follow the procedures set forth in the plan.

4.3 Informational Briefings

It is the responsibility of each NRT staff member directing field operations to keep their crew members appraised of site conditions relative to health and safety, and of any approved modifications to the plan. This will be accomplished through ongoing "tailgate" meetings. All personnel are required to report injuries, illnesses and unsafe conditions to their immediate supervisor. The supervisor is required to report in writing any such accidents to the PM and PHSO within 24 hours of occurrence.

5 PERSONAL PROTECTIVE EQUIPMENT

Listed in the health and safety plan summary at the very beginning of this plan are hazardous substances that have been found or are suspected to be present at the site. Hazardous substances are most likely found in soil and groundwater. Routes of exposure include: inhalation, ingestion, and absorption. Proper PPE should be worn when applicable.

5.1 Drilling/Excavation/Installation of Wells

Persons handling contaminated or potentially contaminated equipment, soils, sediment or water must wear the following PPE:

- Long sleeve coveralls (light or heavy weights subject to ambient temperature);
- Bib style rain pants where wet operations exist;
- Nitrile gloves;
- Vinyl gloves for sample handling;
- Safety glasses with side-shields; (REQUIRED AT ALL TIMES)
- Hard hat; (REQUIRED AT ALL TIMES)
- Steel-toed boots; (REQUIRED AT ALL TIMES)
- Reflective orange vest; (worn as the situation warrants) and
- Hearing protection (as required – see note below).

NOTE: Guidance on the requirements of ear protection is as follows: if you must raise your voice to converse with persons three feet away from you, you are probably being overexposed to noise. In these instances, the wearing of hearing protection is required. The muff or "EAR" type disposable earplugs will suffice.

5.2 Ground/Surface Water and Soil/Sediment Sampling

Persons sampling contaminated or potentially contaminated materials, soil, sediment, or water must wear the following PPE:

- Long sleeve coveralls (light or heavy weights subject to ambient temperature);
- Bib style rain pants where wet operations exist;
- Nitrile gloves;
- Vinyl gloves for sample handling;
- Safety glasses with side-shields;
- Steel-toed boots; and
- Hearing protection (as required).

Persons whose skin or inner clothing comes in contact with contaminated soils or liquids should remove such clothing, shower or clean as appropriate, then re-suit for continued work activities.

NOTE: Outer gloves should be changed between samples if contact to the sample occurs. This will preserve sample integrity.

5.3 Soil Vapor Sampling

Persons sampling contaminated or potentially contaminated vapor must wear the following PPE:

- Nitrile gloves;
- Safety glasses with side-shields; and
- Steel-toed boots.

6 MEDICAL SURVEILLANCE REQUIREMENTS

6.1 Medical Surveillance

The hazardous substances known or suspected to be present at the site are not known to produce injury or illness that would not be detected by the medical examination specified in the NRT Standard Practices Manual, Section 6, Health and Safety, Number 06-10. The medical monitoring program established in this section of the Standard Practices Manual complies with all OSHA guidelines regarding and necessitating medical monitoring in the work place.

7 FREQUENCY AND TYPES OF AIR MONITORING/SAMPLING

7.1 Site Air Monitoring

A PID and possibly a combustible gas indicator (CGI) will be used to measure air contaminant concentrations in the breathing and work zones. Readings are to be recorded on the logs and in the project logbook. The PID will be calibrated per the air monitoring action plan below. If a CGI is also used to detect combustible conditions at the work site, the monitoring will also follow the plan below.

7.2 Sampling Air Monitoring

A PID may be used to measure air contaminant concentrations at the well head or at vapor or soil sampling locations during sampling. If measurements are collected, they should be recorded in the project logbook. The PID will be calibrated at the start of each day of use. Air monitoring should follow the action plan below.

7.3 Air Monitoring Action Plan

A PhotoVac MicroTip 3000 PID (or equivalent), if used, will be calibrated and checked on a minimum basis at least three times per day: 1) before work activities begin; 2) during lunch break or approximately half way through the working day; and 3) following work activities at the end of the day. These calibration checks will be used to ensure accuracy of VOC readings. Calibration procedures will follow those outlined in the PID manual and NRT's SOPs.

The PID may be used to monitor air quality in the breathing zone of the work area for the presence of VOC vapor levels during intrusive work, such as soil boring, that penetrates soil with odor, staining, or free product present. Prior to Contractor Personnel entering any excavations to install piping or any other equipment, the PID will be lowered into the excavation to determine air quality in the excavation. Confined spaces will not be entered. Besides using

the PID to monitor VOC vapors in the breathing zone, an oxygen meter may also be used. The oxygen meter may be used to measure percent oxygen in any excavation. Calibration of the combustible gas meter is required based on use to insure accuracy.

The VOCs "action level" is considered when a reading of 50 ppm is sustained on the PID when the PID is held at a constant height, whether in the excavation or the breathing zone. Reaching the VOC action level will require use of either full-face or half-face respirators utilizing Organic Vapor cartridge filters. Additionally, further air quality monitoring will be required to ensure that the PID readings do not exceed a sustained reading of 500 ppm. This will be done under the direction of the NRT PHSO who will determine specific modifications to work practices and PPE requirements.

If the 500-ppm action level is achieved, all activities on the site will immediately stop. The NRT PM will be contacted prior to taking any further action on the site, unless a situation exists which requires immediate action. Options such as nitrogen purging will be considered based on the most current information available.

8 SITE CONTROL MEASURES

8.1 Buddy System

Each worker will maintain visual contact with another worker at all times. The buddy system will ensure against an employee becoming stressed with a co-worker being aware of his or her condition. Workers should watch out for each other while working close to potential chemical and physical hazards. For example, all work in the exclusion zone should be scheduled so that no employee works alone in this zone at any time.

8.2 Safe Work Practices

To prevent accidental ingestion of chemical contaminants, the following rules must be compiled with when working within the exclusion/contamination reduction zones, and when taking or handling samples. Further, NRT's SOPs for groundwater and soil sampling, and drilling/excavation/well installation will be included in the Multi-Site QAPP and FSP.

- No eating, drinking, or smoking is allowed at work locations.
- No fires are allowed at work locations unless approved by the Project Health and Safety Officer on a site-specific, task-specific basis. If fires or propane torches are used, fires will be maintained away from potential ignition sources and site personnel will not leave the fire unattended and a fire extinguisher will be immediately available.
- All personnel must wash their hands, arms, face, and neck immediately after leaving the exclusion/contamination reduction zones. This must also be done after taking samples and prior to eating, drinking, smoking, or using the restroom.

8.3 Work Zone Definition

All work crews, whether drilling, excavating or performing other activities, must prevent the uncontrolled movement of contaminated or potentially contaminated soil and water. All soil and water removed from its natural setting should be considered contaminated unless proven otherwise by chemical analysis or specifically known to be clean material in which verification

sampling is occurring. Work crews will prevent migration of removed materials by establishing work zones and decontamination procedures. Work zones will be delineated. Only persons certified as having the necessary training and medical qualifications will be allowed in the Exclusion Zone (EZ) or Contamination Reduction Zone (CRZ). The following describes the zones to be established during drilling or excavation:

- Exclusion Zone – An EZ will be established surrounding the drilling or excavation site, if necessary. The EZ will comprise an area of at least as large as a circle having a diameter equaling one half the mast height of the drilling equipment or arm of excavating equipment. The size and shape of the EZ will be determined by the PHSO. No personnel will be permitted in the EZ unless they are in full compliance with the site health and safety plan.

- Contamination Reduction Zone - A CRZ is to provide a controlled area for performing decontamination. If a CRZ is necessary for the job, the size and the shape of the CRZ will be determined by the PHSO.

8.4 Daily Start-up and Shutdown Procedures

The following protocols will be followed daily prior to the start of work activities:

- The PHSO will review site conditions to determine if modifications of the work and safety plans are needed;

- Personnel will be briefed and updated on any new safety procedures based on the previous day's findings and the planned work activity for that day;

- All safety equipment will be checked for proper function;

- The PHSO will ensure that the first aid equipment is readily available; and

- The PHSO will initiate appropriate monitoring.

The following protocol will be followed at the end of daily operations and before breaks:

- All personnel will proceed through appropriate decontamination procedures and facilities;

- The work site will be left clean. Drums will be properly labeled and staged; and

- All PPE must be removed prior to eating, drinking, smoking, or using the restroom.

8.5 Equipment

Drilling rigs and heavy equipment should be inspected at the start of each day to detect equipment problems. Particular attention should be paid to cables and hydraulic lines. Examine them for evidence of stretching, fraying and cracking. The fuel system should be in good repair (free from leaks) to avoid the potential for fire or explosion. The drill rig and heavy equipment should be equipped with or have stationed in the area two 20-lb. type BC fire extinguishers.

8.6 Drilling/Excavation Area

The drilling/excavation area should be located away from overhead electrical lines. The location of buried water, electrical, telephone, and gas utility lines must be determined and staked. Slope of terrain, stability of embankments, soil load bearing ability, etc. should be evaluated in selection of the drilling/excavation locations.

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9 DECONTAMINATION PLAN

9.1 Decontamination Procedures

Personal decontamination will be accomplished by using good personal hygiene. Personal contamination should not occur if the protection methods specified in this plan are used. However, the following procedures must be complied with to ensure that contamination does not remain on equipment, sample containers, or in contact with personnel.

- While in the EZ clean gross contamination off equipment by scraping or brushing. Collect all contaminated soil with the drill cuttings and transport the cuttings in an appropriate manner to the staging area on site (i.e. placed in DOT approved 55-gallon drums).

- If steam cleaning of equipment is required it will occur at the designated area on site. If capture of decontamination water is required, it will be placed in DOT approved 55-gallon drums.

After equipment and sample container decontamination is accomplished, drilling crewmembers must remove PPE before leaving the CRZ. PPE must be removed in a step-wise fashion to prevent contamination of work clothing, as follows:

- Remove all contaminated soil from work boots and remove protective clothing for decontamination or disposal. If disposable PPE is required, it should be placed in an open top drum designated for that purpose. A lid should be placed on the drum after usage. All drummed material will be labeled identifying contents and the date filled.

- Remove and wash outer gloves and hard hat. Place disposable gloves in a collection bag.

- The use of respiratory protection is not anticipated. If a respirator must be used or otherwise removed from its containers, wash it down and take it with you as you exit the CRZ.

- Final daily decontamination will be reviewed by the PHSO to ensure that no contaminated articles are left which may be accessible to the public. Therefore, all disposable PPE and other miscellaneous garbage will be stored in a drum with a secured lid.

After leaving the CRZ, and before eating, drinking, smoking, or using the restroom, all personnel must wash their hands, arms, face, and neck. In addition, all personnel should take a full-body shower at the end of the workday. A full-body shower includes the use of a wash cloth to scrub the skin.

9.2 Waste Storage and Disposal

Since all soil and water removed from its natural setting is considered potentially contaminated, these materials will be stored and disposed of according to the guidelines established in the Work Plan for the site. If no guidelines have been established in the work plan for storage and disposal of these investigative wastes, the procedures outlined in NRT Standard Practices Manual, Section 6, Health and Safety, Number 06-07 with the WDNR Investigative Waste Policy attachments will be followed in storing and disposing of the wastes.

Waste container contents and identification will be made in the field log for future reference. All containers will be distinctly labeled using a paint pen or marker.

10 EMERGENCY ACTION PLAN

10.1 Medical Emergencies

In the event of a medical emergency, the following procedures should be used.

1. If serious injury or life-threatening condition exists, call 911. Clearly describe the location, injury and conditions to the dispatcher. Designate a person to direct emergency responders to the injured person(s).
2. Call the project manager.
3. Implement steps to prevent the reoccurrence of the accident.

10.2 Chemical Emergencies

1. If serious injury or life-threatening condition exists, call 911. Clearly describe the location, injury and conditions to the dispatcher.
2. Evacuate other on-site personnel to a safe place in an upwind direction until it is safe for work to resume.
3. Call the PM.
4. If necessary contact clean-up contractor.
5. If release requires contacting government agencies the PM makes the appropriate calls (PM also contacts Client).

10.3 General Emergencies

In the case of fire (other than a managed pre-approved fire, discussed in Section 8.2), flood, explosion, spills, severe weather, tank or pipe punctures, or other hazard, work shall be halted and if applicable, 911 called. All on-site personnel will immediately be evacuated to a safe place.

10.4 Accident Reports and Follow up

All accidents, including those that do not result in injury or illness, are to be reported to the PHSO or the PM within 24 hours of their occurrence. The report form to be used can be seen on the following page. The policy specified in the NRT Standard Practices Manual, Section 6, Health and Safety, Number 06-12 regarding notification of the PHSO or PM will be followed.

NRT's Accident/Injury Report Form **Project No. 2034**

Date: _____ Time: _____

Location of Incident: _____

Was Anyone Injured _____ Name of Injured: _____

Describe Company First Aid (If Applicable): _____

Physician's Treatment (If Applicable): _____

Description of Incident: _____

Corrective Action: _____

Additional Comments: _____

Reported By: _____

Distribution:
Corp. H & S Dir. _____
Project Manager: _____ Other: _____

11 CONFINED SPACE ENTRY PROCEDURES

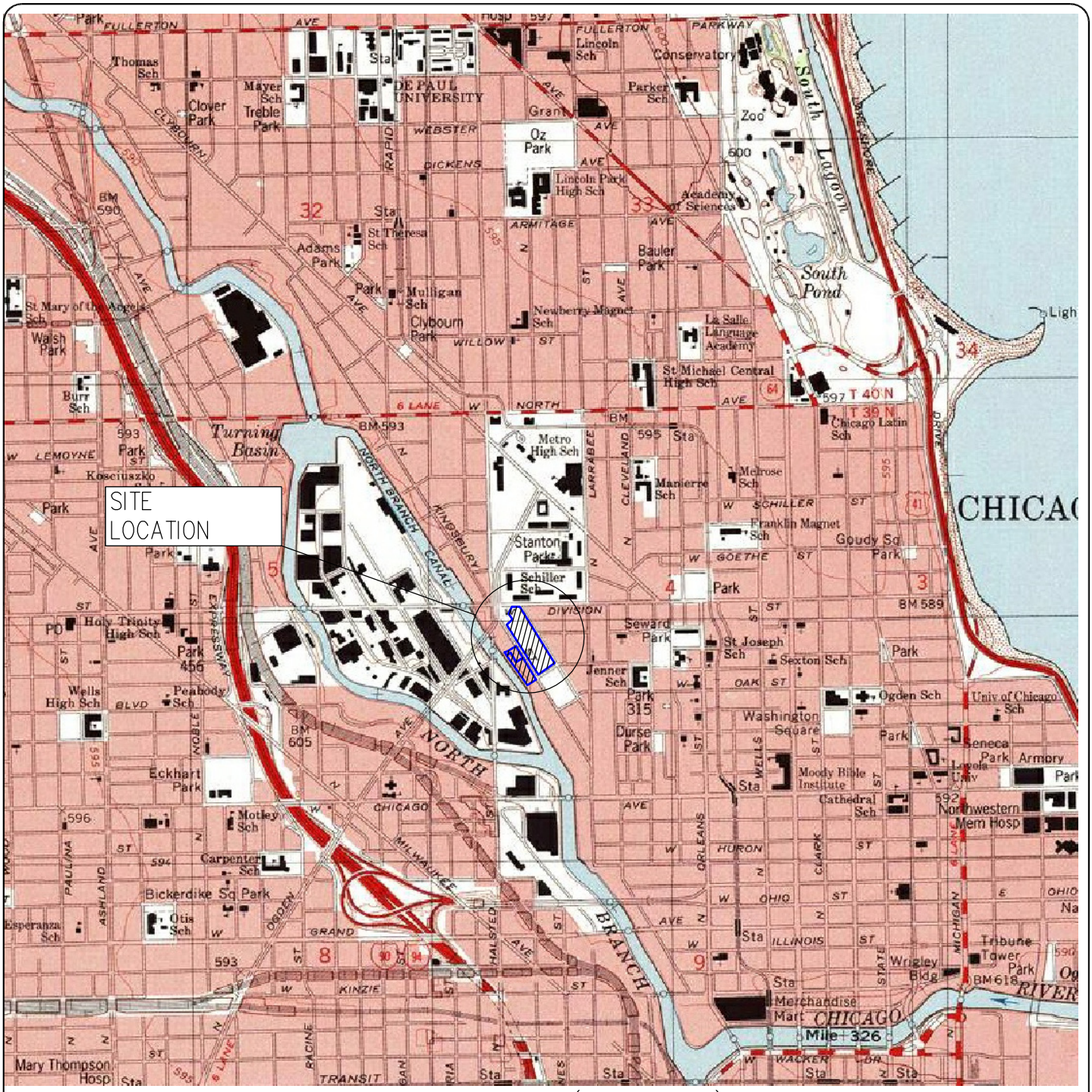
No confined spaces (or the need to enter a confined space) are anticipated on any of the WPSC sites; however, should such an issue arise (or become anticipated at a particular site), it will be addressed in the site specific work plan.

12 SPILL CONTAINMENT PROGRAM

No potential spill situations are anticipated on any of the WPSC sites; however, if there is an accidental release of potentially hazardous materials or waste (i.e. spilled purge water or soil cuttings, ruptured hydraulic line, or boat fuel or oil), site personnel will:

- Contact the Project Health and Safety Officer and Project Manager;
- Contain the spill, if it is possible and it can be done safely; and
- Initiate cleanup.

Figures



SOURCE: TOPO! © 2001 NATIONAL GEOGRAPHIC HOLDINGS (www.topo.com)

NORTH

2000 0 2000 4000

SCALE IN FEET

SITE LOCATION MAP

NATURAL RESOURCE TECHNOLOGY

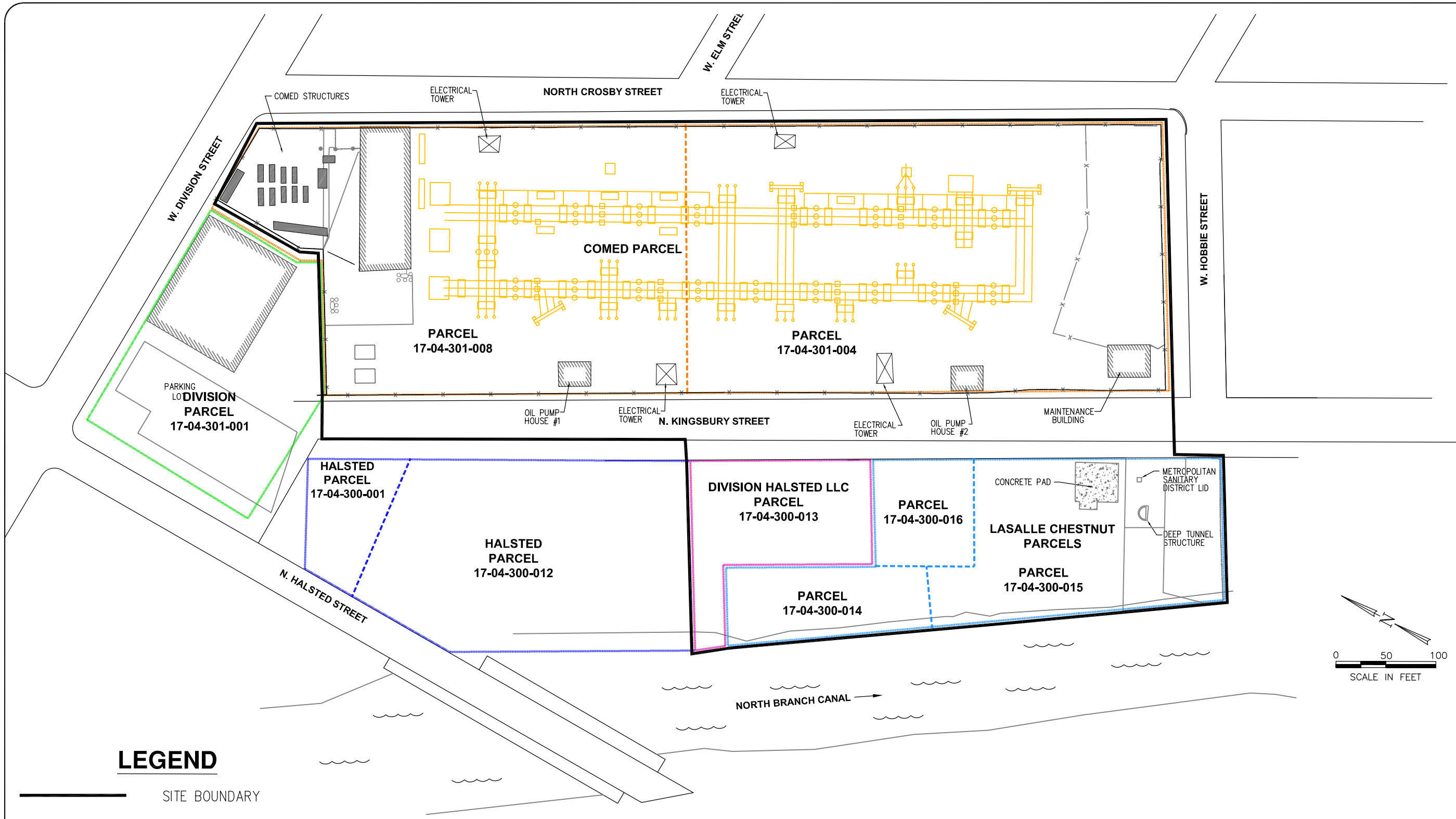
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

DRAWN BY: RLH 06/13/11 APP'D BY: RJK DATE: 06/13/11

PROJECT NO.
2034/4

DRAWING NO.
FIG-1

FIGURE NO.
1



LEGEND

- SITE BOUNDARY
- FENCE
- ABANDONED GAS MAIN
- BUS STRUCTURE
- BUILDING
- LA SALLE CHESTNUT PROPERTY BOUNDARY
- DIVISION HALSTED PROPERTY BOUNDARY
- HALSTED PROPERTY BOUNDARY
- DIVISION PROPERTY BOUNDARY
- COMED PROPERTY BOUNDARY

NOTES:
1. COMED BUS STRUCTURE SCANNED FROM COMED "PLAN OF PROPERTY & EQUIPMENT ULTIMATE" CREATED 09/24/63 REVISED 07/30/99, NOT TO SCALE

SOURCE NOTE:
THIS DRAWING WAS DEVELOPED FROM DIGITIAL FILE "SITE LAYOUT.dwg" BY BURNS & MC DONNELL, DATE UNKNOWN.

DRAWN BY: RLH/SJD DATE: 06/10/11
CHECKED BY: RJK DATE: 06/13/11
APPROVED BY: JMK DATE: 06/13/11
DRAWING NO: FIG-2
REFERENCE:.

SITE LAYOUT MAP

NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2034/4.0

FIGURE NO.
2

Appendix A
Material Safety Data Sheets

- Benzene
- Ethylbenzene
- Toluene
- Xylenes (M, O, & P)
- PAHs (Technical Sheet)
- Phenols
- Naphtha (Coal Tar)
- Cyanide
- PCBs
- Arsenic
- Cadmium
- Chromium
- Lead
- Mercury
- Alconox
- Liquinox
- Hydrochloric Acid
- Methanol (MeOH)
- Non-Flammable Calibration Gas
- Nitric Acid
- Sodium Hydroxide
- Sulfuric Acid

BENZENE

BNZ

CAUTIONARY RESPONSE INFORMATION

Common Synonyms
Benzol
Benzole

Watery liquid Colorless Gasoline-like odor

Floats on water. Flammable, irritating vapor is produced. Freezing point is 42°F.

Restrict access.
Avoid contact with liquid and vapor.
Wear goggles and self-contained breathing apparatus.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to ``knock down'' vapor.
Notify local health and pollution control agencies.
Protect water intakes.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause headache, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain
Collection Systems: Skim
Chemical and Physical Treatment: Burn
Salvage waterfowl

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: 32; Aromatic Hydrocarbon
2.2 Formula: C_6H_6
2.3 IMO/UN Designation: 3.2/1114
2.4 DOT ID No.: 1114
2.5 CAS Registry No.: 71-43-2
2.6 NAERG Guide No.: 130
2.7 Standard Industrial Trade Classification: 51122

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Self contained positive pressure breathing apparatus; protective gloves and clothing.
3.2 Symptoms Following Exposure: Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction, nausea, and vomiting. Coma and possible death.
3.3 Treatment of Exposure: SKIN: flush with water followed by soap and water; remove contaminated clothing and wash skin. EYES: flush with plenty of water until irritation subsides. INHALATION: remove from exposure immediately. Call a physician. IF breathing is irregular or stopped, start resuscitation, administer oxygen.
3.4 TLV-TWA: 0.5 ppm
3.5 TLV-STEL: 2.5 ppm
3.6 TLV-Ceiling: Not listed
3.7 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: Leukemia.
3.10 Vapor (Gas) Irritant Characteristics: If present in high concentrations, vapors may cause irritation of eyes or respiratory system. The effect is temporary.
3.11 Liquid or Solid Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
3.12 Odor Threshold: 4.68 ppm
3.13 IDLH Value: 500 ppm
3.14 OSHA PEL-TWA: 1 ppm.
3.15 OSHA PEL-STEL: 5 ppm
3.16 OSHA PEL-Ceiling: Not listed
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: 12°F C.C.
4.2 Flammable Limits in Air: 1.3%-7.9%
4.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide.
4.4 Fire Extinguishing Agents Not to Be Used: Water may be ineffective.
4.5 Special Hazards of Combustion Products: Not pertinent.
4.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
4.7 Auto Ignition Temperature: 1097°F
4.8 Electrical Hazards: Class I, Group D
4.9 Burning Rate: 6.0 mm/min.
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichometric Air to Fuel Ratio: 35.7 (calc.)
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): 9.0 (calc.)
4.14 Minimum Oxygen Concentration for Combustion (MOCC): Not listed

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: No reaction.
5.2 Reactivity with Common Materials: No reaction.
5.3 Stability During Transport: Stable.
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent.
5.5 Polymerization: Not pertinent.
5.6 Inhibitor of Polymerization: Not pertinent.

6. WATER POLLUTION

6.1 Aquatic Toxicity: 5 ppm/6 hr/minnow/lethal/distilled water
20 ppm/24 hr/sunfish/TL_m/tap water
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): 1.2 lb/lb, 10 days
6.4 Food Chain Concentration Potential: None.
6.5 GESAMP Hazard Profile:
Bioaccumulation: 0
Damage to living resources: 2
Human Oral hazard: 1
Human Contact hazard: II
Reduction of amenities: XXX

7. SHIPPING INFORMATION

7.1 Grades of Purity: Industrial pure – 99+%; Thiophene-free – 99+%; Nitration – 99+%; Industrial – 90% - 85+%; Reagent – 99+%
7.2 Storage Temperature: Ambient.
7.3 Inert Atmosphere: No requirement.
7.4 Venting: Pressure-vacuum.
7.5 IMO Pollution Category: C
7.6 Ship Type: 3
7.7 Barge Hull Type: 3

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Flammable liquid
8.2 49 CFR Class: 3
8.3 49 CFR Package Group: II
8.4 Marine Pollutant: No
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue).....	2
Flammability (Red).....	3
Instability (Yellow).....	0

8.6 EPA Reportable Quantity: 10 pounds
8.7 EPA Pollution Category: A
8.8 RCRA Waste Number: U019
8.9 EPA FWPCA List: Yes

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: 78.11
9.3 Boiling Point at 1 atm: 176°F = 80.1°C = 353.3°K
9.4 Freezing Point: 42.0°F = 5.5°C = 278.7°K
9.5 Critical Temperature: 552.0°F = 288.9°C = 562.1°K
9.6 Critical Pressure: 710 psia = 48.3 atm = 4.89 MN/m^2
9.7 Specific Gravity: 0.879 at 20°C (liquid)
9.8 Liquid Surface Tension: 28.9 dynes/cm = 0.0289 N/m at 20°C
9.9 Liquid Water Interfacial Tension: 35.0 dynes/cm = 0.035 N/m at 20°C
9.10 Vapor (Gas) Specific Gravity: 2.8
9.11 Ratio of Specific Heats of Vapor (Gas): 1.061
9.12 Latent Heat of Vaporization: 169 Btu/lb = 94.1 cal/g = 3.94 X 10^5 J/kg
9.13 Heat of Combustion: –17,460 Btu/lb = –9698 cal/g = –406.0 X 10^5 J/kg
9.14 Heat of Decomposition: Not pertinent.
9.15 Heat of Solution: Not pertinent.
9.16 Heat of Polymerization: Not pertinent.
9.17 Heat of Fusion: 30.45 cal/g
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: 3.22 psia

NOTES

BENZENE

BNZ

9.20 SATURATED LIQUID DENSITY	
Temperature (degrees F)	Pounds per cubic foot
55	55.330
60	55.140
65	54.960
70	54.770
75	54.580
80	54.400
85	54.210
90	54.030
95	53.840
100	53.660
105	53.470
110	53.290
115	53.100
120	52.920
125	52.730
130	52.540
135	52.360
140	52.170
145	51.990
150	51.800
155	51.620
160	51.430
165	51.250
170	51.060
175	50.870

9.21 LIQUID HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
45	0.394
50	0.396
55	0.398
60	0.400
65	0.403
70	0.405
75	0.407
80	0.409
85	0.411
90	0.414
95	0.416
100	0.418

9.22 LIQUID THERMAL CONDUCTIVITY	
Temperature (degrees F)	British thermal unit inch per hour-square foot-F
75	0.988
80	0.981
85	0.975
90	0.969
95	0.962
100	0.956
105	0.950
110	0.944
115	0.937
120	0.931
125	0.925
130	0.919
135	0.912
140	0.906
145	0.900
150	0.893
155	0.887
160	0.881
165	0.875
170	0.868

9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Centipoise
55	0.724
60	0.693
65	0.665
70	0.638
75	0.612
80	0.588
85	0.566
90	0.544
95	0.524
100	0.505
105	0.487
110	0.470
115	0.453
120	0.438

9.24 SOLUBILITY IN WATER	
Temperature (degrees F)	Pounds per 100 pounds of water
77	0.180

9.25 SATURATED VAPOR PRESSURE	
Temperature (degrees F)	Pounds per square inch
50	0.881
60	1.171
70	1.535
80	1.989
90	2.547
100	3.227
110	4.049
120	5.033
130	6.201
140	7.577
150	9.187
160	11.060
170	13.220
180	15.700
190	18.520
200	21.740
210	25.360

9.26 SATURATED VAPOR DENSITY	
Temperature (degrees F)	Pounds per cubic foot
50	0.01258
60	0.01639
70	0.02109
80	0.02681
90	0.03371
100	0.04196
110	0.05172
120	0.06317
130	0.07652
140	0.09194
150	0.10960
160	0.12980
170	0.15270
180	0.17850
190	0.20750
200	0.23970
210	0.27560

9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
0	0.204
25	0.219
50	0.234
75	0.248
100	0.261
125	0.275
150	0.288
175	0.301
200	0.313
225	0.325
250	0.337
275	0.349
300	0.360
325	0.371
350	0.381
375	0.392
400	0.402
425	0.412
450	0.421
475	0.431
500	0.440
525	0.449
550	0.457
575	0.465
600	0.474

BENZENE

Also known as: Benzol, Mineral Naphtha, Phenyl Hydride, Annulene
Chemical reference number (CAS): 71-43-2

WHAT IS BENZENE?

Benzene is a widely used industrial chemical. Benzene is found in crude oil and is a major part of gasoline. It's used to make plastics, resins, synthetic fibers, rubber lubricants, dyes, detergents, drugs and pesticides. Benzene is produced naturally by volcanoes and forest fires.

In homes, benzene may be found in glues, adhesives, cleaning products, paint strippers, tobacco smoke and gasoline. Most benzene in the environment comes from our use of petroleum products.

Benzene quickly evaporates from water or soil. If benzene leaks from buried storage tanks or landfills, it can contaminate nearby drinking water wells. Benzene can move long distances in groundwater.

HOW ARE PEOPLE EXPOSED TO BENZENE?

Breathing: The most common way people are exposed to benzene is when they fill their car with gasoline. People are also exposed to benzene when they use household products that contain benzene.

Benzene evaporates quickly from contaminated water. People can be exposed to benzene if they use contaminated water to bathe, shower, wash dishes or do laundry.

Benzene vapors are present in exhaust from many industries and automobiles. People who live near highways or industries can be exposed to benzene.

Drinking/Eating: People whose drinking water wells are located within half a mile of leaking underground storage tank, may be exposed by drinking contaminated water.

Touching: Benzene can pass through the skin. Benzene exposure through skin contact with gasoline or other solvents is possible. People can also absorb benzene as they bathe or shower in contaminated water.

DO STANDARDS EXIST FOR REGULATING BENZENE?

Water: The state and federal drinking water standards for benzene are both set at 5 parts per billion (ppb). We suggest you stop drinking water that contains more than 5 ppb of benzene. If the level of benzene in your water is higher than 100 ppb, you may also need to avoid washing, bathing or using the water for other purposes. Contact your local public health agency for more information specific to your situation.

Air: No standards exist for the amount of benzene allowed in the air of homes. We recommend that people with any detectable levels of benzene in the air of their homes eliminate the source of the contamination (gasoline in cans, contaminated drinking water, etc.) Most people can smell benzene at levels above 5 parts per million (ppm) in air.

WILL EXPOSURE TO BENZENE RESULT IN HARMFUL HEALTH EFFECTS?

Drowsiness, headaches, and dizziness have been reported when people breathed air with benzene levels of more than 10 ppm for a short time.

The following health effects can occur after several years of exposure to benzene:

Cancer: Long-term exposure to benzene can increase the risk of developing leukemia.

Reproductive Effects: Animal studies show that inhaling benzene vapors can damage reproductive organs and cause infertility. Exposure to benzene in workplaces has caused menstrual variations.

Organ Systems: Exposure to benzene can cause anemia and weaken the immune system.

In general, chemicals affect the same organ systems in all people who are exposed. However, the seriousness of the effects may vary from person to person.

A person's reaction depends on several things, including individual health, heredity, previous exposure to chemicals including medicines, and personal habits such as smoking or drinking.

It is also important to consider the length of exposure to the chemical; the amount of chemical exposure; and whether the chemical was inhaled, touched, or eaten.

CAN A MEDICAL TEST DETERMINE EXPOSURE TO BENZENE?

Benzene breaks down in the body to several other compounds. Those compounds can be found in the blood or urine of people who have been exposed to high levels of benzene within the past two days. Tests will prove an exposure to benzene occurred but will not predict the kind of illness that could result. We do not know what level of benzene break-down products are common in most people, since most people are regularly exposed to some amount of benzene.

People who think they have been exposed to benzene over a long period of time should contact their doctor. Physicians can use blood chemistry, liver function and kidney function tests.

Seek medical advice if you have any symptoms that you think may be related to chemical exposure.

This fact sheet summarizes information about this chemical and is not a complete listing of all possible effects. It does not refer to work exposure or emergency situations.

FOR MORE INFORMATION

- Poison Control Center, 800-815-8855
- Your local public health agency
- Division of Public Health, BEH, 1 West Wilson Street, Rm. 150, Madison, WI 53701-2659, (608) 266-1120 or Internet: www.dhfs.state.wi.us/eh/index.htm

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ETHYLBENZENE

ETB

CAUTIONARY RESPONSE INFORMATION

Common Synonyms			
EB Phenylethane	Liquid	Colorless	Sweet, gasoline-like odor

Floats on water. Flammable, irritating vapor is produced.

Keep people away. Avoid contact with liquid and vapor.
Avoid inhalation.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Shut off ignition sources and call fire department.
Stay upwind and use water spray to ``knock down'' vapor.
Notify local health and pollution control agencies.
Protect water intakes.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain
Collection Systems: Skim
Clean shore line
Salvage waterfowl

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: 32; Aromatic Hydrocarbon
2.2 Formula: $C_6H_5CH_2CH_3$
2.3 IMO/UN Designation: 3.3/1175
2.4 DOT ID No.: 1175
2.5 CAS Registry No.: 100-41-4
2.6 NAERG Guide No.: 129
2.7 Standard Industrial Trade Classification: 51126

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Self-contained breathing apparatus; safety goggles.
3.2 Symptoms Following Exposure: Inhalation may cause irritation of nose, dizziness, depression. Moderate irritation of eye with corneal injury possible. Irritates skin and may cause blisters.
3.3 Treatment of Exposure: INHALATION: if ill effects occur, remove victim to fresh air, keep him warm and quiet, and get medical help promptly; if breathing stops, give artificial respiration. INGESTION: induce vomiting only upon physician's approval; material in lung may cause chemical pneumonitis. SKIN AND EYES: promptly flush with plenty of water (15 min. for eyes) and get medical attention; remove and wash contaminated clothing before reuse.
3.4 TLV-TWA: 100 ppm
3.5 TLV-STEL: Not listed.
3.6 TLV-Ceiling: 125 ppm
3.7 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg (rat)
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: Currently not available
3.10 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.
3.11 Liquid or Solid Characteristics: Causes smarting of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure.
3.12 Odor Threshold: 140 ppm
3.13 IDLH Value: 800 ppm
3.14 OSHA PEL-TWA: 100 ppm
3.15 OSHA PEL-STEL: Not listed.
3.16 OSHA PEL-Ceiling: Not listed.
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: 80°F O.C. 59°F C.C.
4.2 Flammable Limits in Air: 1.0%-6.7%
4.3 Fire Extinguishing Agents: Foam (most effective), water fog, carbon dioxide or dry chemical.
4.4 Fire Extinguishing Agents Not to Be Used: Not pertinent
4.5 Special Hazards of Combustion Products: Irritating vapors are generated when heated.
4.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to the source of ignition and flash back.
4.7 Auto Ignition Temperature: 860°F
4.8 Electrical Hazards: Not pertinent
4.9 Burning Rate: 5.8 mm/min.
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichometric Air to Fuel Ratio: 50.0 (calc.)
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): 13.0 (calc.)
4.14 Minimum Oxygen Concentration for Combustion (MOCC): N_2 diluent: 9.0%

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: No reaction
5.2 Reactivity with Common Materials: No reaction
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity: 29 ppm/96 hr/bluegill/TL_m/fresh water
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): 2.8% (theor.), 5 days
6.4 Food Chain Concentration Potential: None
6.5 GESAMP Hazard Profile:
Bioaccumulation: 0
Damage to living resources: 3
Human Oral hazard: 1
Human Contact hazard: I
Reduction of amenities: XX

7. SHIPPING INFORMATION

7.1 Grades of Purity: Research grade: 99.98%; pure grade: 99.5%; technical grade: 99.0%
7.2 Storage Temperature: Ambient
7.3 Inert Atmosphere: No requirement
7.4 Venting: Open (flame arrester) or pressure-vacuum
7.5 IMO Pollution Category: B
7.6 Ship Type: 3
7.7 Barge Hull Type: Currently not available

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Flammable liquid
8.2 49 CFR Class: 3
8.3 49 CFR Package Group: II
8.4 Marine Pollutant: No
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue).....	2
Flammability (Red).....	3
Instability (Yellow).....	0

8.6 EPA Reportable Quantity: 1000 pounds
8.7 EPA Pollution Category: C
8.8 RCRA Waste Number: Not listed
8.9 EPA FWPCA List: Yes

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: 106.17
9.3 Boiling Point at 1 atm: 277.2°F = 136.2°C = 409.4°K
9.4 Freezing Point: –139°F = –95°C = 178°K
9.5 Critical Temperature: 651.0°F = 343.9°C = 617.1°K
9.6 Critical Pressure: 523 psia = 35.6 atm = 3.61 MN/m^2
9.7 Specific Gravity: 0.867 at 20°C (liquid)
9.8 Liquid Surface Tension: 29.2 dynes/cm = 0.0292 N/m at 20°C
9.9 Liquid Water Interfacial Tension: 35.48 dynes/cm = 0.03548 N/m at 20°C
9.10 Vapor (Gas) Specific Gravity: Not pertinent
9.11 Ratio of Specific Heats of Vapor (Gas): 1.071
9.12 Latent Heat of Vaporization: 144 Btu/lb = 80.1 cal/g = 3.35 X 10^5 J/kg
9.13 Heat of Combustion: –17,780 Btu/lb = –9877 cal/g = –413.5 X 10^5 J/kg
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: Currently not available
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: 0.4 psia

NOTES

ETHYLBENZENE

ETB

9.20 SATURATED LIQUID DENSITY	
Temperature (degrees F)	Pounds per cubic foot
40	54.990
50	54.680
60	54.370
70	54.060
80	53.750
90	53.430
100	53.120
110	52.810
120	52.500
130	52.190
140	51.870
150	51.560
160	51.250
170	50.940
180	50.620
190	50.310
200	50.000
210	49.690

9.21 LIQUID HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
40	0.402
50	0.404
60	0.407
70	0.409
80	0.412
90	0.414
100	0.417
110	0.419
120	0.421
130	0.424
140	0.426
150	0.429
160	0.431
170	0.434
180	0.436
190	0.439
200	0.441
210	0.443

9.22 LIQUID THERMAL CONDUCTIVITY	
Temperature (degrees F)	British thermal unit inch per hour-square foot-F
-90	1.065
-80	1.056
-70	1.047
-60	1.037
-50	1.028
-40	1.018
-30	1.009
-20	1.000
-10	0.990
0	0.981
10	0.971
20	0.962
30	0.953
40	0.943
50	0.934
60	0.924
70	0.915
80	0.906
90	0.896
100	0.887
110	0.877
120	0.868
130	0.859
140	0.849
150	0.840
160	0.830

9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Centipoise
40	0.835
50	0.774
60	0.719
70	0.670
80	0.626
90	0.586
100	0.550
110	0.518
120	0.488
130	0.461
140	0.436
150	0.414
160	0.393
170	0.374
180	0.356
190	0.340
200	0.325
210	0.311

9.24 SOLUBILITY IN WATER	
Temperature (degrees F)	Pounds per 100 pounds of water
68	0.020

9.25 SATURATED VAPOR PRESSURE	
Temperature (degrees F)	Pounds per square inch
80	0.202
100	0.370
120	0.644
140	1.071
160	1.713
180	2.643
200	3.953
220	5.747
240	8.147
260	11.290
280	15.320
300	20.410
320	26.730
340	34.460
360	43.800
380	54.950

9.26 SATURATED VAPOR DENSITY	
Temperature (degrees F)	Pounds per cubic foot
80	0.00370
100	0.00654
120	0.01099
140	0.01767
160	0.02734
180	0.04087
200	0.05926
220	0.08363
240	0.11520
260	0.15510
280	0.20490
300	0.26570
320	0.33910
340	0.42620
360	0.52850
380	0.64720

9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
-400	-0.007
-350	0.026
-300	0.060
-250	0.093
-200	0.125
-150	0.157
-100	0.187
-50	0.217
0	0.246
50	0.274
100	0.301
150	0.327
200	0.353
250	0.377
300	0.401
350	0.424
400	0.446
450	0.467
500	0.487
550	0.507
600	0.525

TOLUENE

TOL

CAUTIONARY RESPONSE INFORMATION

Common Synonyms	Watery liquid	Colorless	Pleasant odor
Methylbenzene Methylbenzol Toluol	Floats on water. Flammable, irritating vapor is produced.		

Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to ``knock down'' vapor.
Avoid contact with liquid and vapor.
Notify local health and pollution control agencies.
Protect water intakes.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, vomiting, headache, dizziness, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain
Collection Systems: Skim
Chemical and Physical Treatment: Burn
Clean shore line
Salvage waterfowl

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: 32; Aromatic Hydrocarbon
2.2 Formula: $C_6H_5CH_3$
2.3 IMO/UN Designation: 3.2/1294
2.4 DOT ID No.: 1294
2.5 CAS Registry No.: 108-88-3
2.6 NAERG Guide No.: 130
2.7 Standard Industrial Trade Classification: 51123

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Air-supplied mask; goggles or face shield; plastic gloves.
3.2 Symptoms Following Exposure: Vapors irritate eyes and upper respiratory tract; cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, griping, diarrhea, depressed respiration.
3.3 Treatment of Exposure: INHALATION: remove to fresh air, give artificial respiration and oxygen if needed; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
3.4 TLV-TWA: 50 ppm
3.5 TLV-STEL: Not listed.
3.6 TLV-Ceiling: Not listed.
3.7 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: Kidney and liver damage may follow ingestion.
3.10 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
3.11 Liquid or Solid Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
3.12 Odor Threshold: 0.17 ppm
3.13 IDLH Value: 500 ppm
3.14 OSHA PEL-TWA: 200 ppm
3.15 OSHA PEL-STEL: 500 ppm, 10 minute peak once in 8 hour shift
3.16 OSHA PEL-Ceiling: 300 ppm
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: 55°F O.C. 40°F C.C.
4.2 Flammable Limits in Air: 1.27%-7%
4.3 Fire Extinguishing Agents: Carbon dioxide or dry chemical for small fires, ordinary foam for large fires.
4.4 Fire Extinguishing Agents Not to Be Used: Water may be ineffective
4.5 Special Hazards of Combustion Products: Not pertinent
4.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back.
4.7 Auto Ignition Temperature: 896°F
4.8 Electrical Hazards: Class I, Group D
4.9 Burning Rate: 5.7 mm/min.
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichometric Air to Fuel Ratio: 42.8 (calc.)
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): 11.0 (calc.)
4.14 Minimum Oxygen Concentration for Combustion (MOCC): N_2 diluent: 9.5%

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: No reaction
5.2 Reactivity with Common Materials: No reaction
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity: 1180 mg/l/96 hr/sunfish/TL_m/fresh water
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): 0%, 5 days; 38% (theor), 8 days
6.4 Food Chain Concentration Potential: None
6.5 GESAMP Hazard Profile:
Bioaccumulation: 0
Damage to living resources: 2
Human Oral hazard: 1
Human Contact hazard: II
Reduction of amenities: XXX

7. SHIPPING INFORMATION

7.1 Grades of Purity: Research, reagent, nitration-all 99.8 + %; industrial: contains 94 + %, with 5% xylene and small amounts of benzene and nonaromatic hydrocarbons; 90/120: less pure than industrial.
7.2 Storage Temperature: Ambient
7.3 Inert Atmosphere: No requirement
7.4 Venting: Open (flame arrester) or pressure-vacuum
7.5 IMO Pollution Category: C
7.6 Ship Type: 3
7.7 Barge Hull Type: Currently not available

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Flammable liquid
8.2 49 CFR Class: 3
8.3 49 CFR Package Group: II
8.4 Marine Pollutant: No
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue).....	2
Flammability (Red).....	3
Instability (Yellow).....	0

8.6 EPA Reportable Quantity: 1000 pounds
8.7 EPA Pollution Category: C
8.8 RCRA Waste Number: U220
8.9 EPA FWPCA List: Yes

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: 92.14
9.3 Boiling Point at 1 atm: 231.1°F = 110.6°C = 383.8°K
9.4 Freezing Point: –139°F = –95.0°C = 178.2°K
9.5 Critical Temperature: 605.5°F = 318.6°C = 591.8°K
9.6 Critical Pressure: 596.1 psia = 40.55 atm = 4.108 MN/m^2
9.7 Specific Gravity: 0.867 at 20°C (liquid)
9.8 Liquid Surface Tension: 29.0 dynes/cm = 0.0290 N/m at 20°C
9.9 Liquid Water Interfacial Tension: 36.1 dynes/cm = 0.0361 N/m at 25°C
9.10 Vapor (Gas) Specific Gravity: Not pertinent
9.11 Ratio of Specific Heats of Vapor (Gas): 1.089
9.12 Latent Heat of Vaporization: 155 Btu/lb = 86.1 cal/g = 3.61 X 10^5 J/kg
9.13 Heat of Combustion: –17,430 Btu/lb = –9686 cal/g = –405.5 X 10^5 J/kg
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: 17.17 cal/g
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: 1.1 psia

NOTES

TOLUENE

TOL

9.20 SATURATED LIQUID DENSITY	
Temperature (degrees F)	Pounds per cubic foot
-30	57.180
-20	56.870
-10	56.550
0	56.240
10	55.930
20	55.620
30	55.310
40	54.990
50	54.680
60	54.370
70	54.060
80	53.750
90	53.430
100	53.120
110	52.810
120	52.500

9.21 LIQUID HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
0	0.396
5	0.397
10	0.399
15	0.400
20	0.402
25	0.403
30	0.404
35	0.406
40	0.407
45	0.409
50	0.410
55	0.411
60	0.413
65	0.414
70	0.415
75	0.417
80	0.418
85	0.420
90	0.421
95	0.422
100	0.424
105	0.425
110	0.427
115	0.428
120	0.429
125	0.431

9.22 LIQUID THERMAL CONDUCTIVITY	
Temperature (degrees F)	British thermal unit inch per hour-square foot-F
0	1.026
10	1.015
20	1.005
30	0.994
40	0.983
50	0.972
60	0.962
70	0.951
80	0.940
90	0.929
100	0.919
110	0.908
120	0.897
130	0.886
140	0.876
150	0.865
160	0.854
170	0.843
180	0.833
190	0.822
200	0.811
210	0.800

9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Centipoise
0	1.024
5	0.978
10	0.935
15	0.894
20	0.857
25	0.821
30	0.788
35	0.757
40	0.727
45	0.700
50	0.673
55	0.649
60	0.625
65	0.603
70	0.582
75	0.562
80	0.544
85	0.526
90	0.509
95	0.493
100	0.477

9.24 SOLUBILITY IN WATER	
Temperature (degrees F)	Pounds per 100 pounds of water
68	0.050

9.25 SATURATED VAPOR PRESSURE	
Temperature (degrees F)	Pounds per square inch
0	0.038
10	0.057
20	0.084
30	0.121
40	0.172
50	0.241
60	0.331
70	0.449
80	0.600
90	0.792
100	1.033
110	1.332
120	1.700
130	2.148
140	2.690
150	3.338
160	4.109
170	5.018
180	6.083
190	7.323
200	8.758
210	10.410

9.26 SATURATED VAPOR DENSITY	
Temperature (degrees F)	Pounds per cubic foot
0	0.00070
10	0.00103
20	0.00150
30	0.00212
40	0.00296
50	0.00405
60	0.00547
70	0.00727
80	0.00954
90	0.01237
100	0.01584
110	0.02007
120	0.02518
130	0.03127
140	0.03850
150	0.04700
160	0.05691
170	0.06840
180	0.08162
190	0.09675
200	0.11400
210	0.13340

9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
0	0.228
25	0.241
50	0.255
75	0.268
100	0.281
125	0.294
150	0.306
175	0.319
200	0.331
225	0.343
250	0.355
275	0.367
300	0.378
325	0.389
350	0.400
375	0.411
400	0.422
425	0.432
450	0.443
475	0.453
500	0.462
525	0.472
550	0.482
575	0.491
600	0.500

TOLUENE

Also known as: Toluol, Methylbenzene, Phenylmethane
Chemical reference number (CAS): 108-88-3

WHAT IS TOLUENE?

Toluene is a common ingredient in degreasers. It's a colorless liquid with a sweet smell and taste. It evaporates quickly. Toluene is found naturally in crude oil. It's used in oil refining and the manufacturing of paints, lacquers, explosives (TNT) and glues. In homes, toluene may be found in paint thinners, paint brush cleaners, nail polish, glues, inks and stain removers. Toluene is also found in car exhaust and the smoke from cigarettes.

When toluene is spilled on the ground or improperly disposed, it can seep into soil and contaminate nearby wells and streams. Toluene can remain unchanged for a long time in soil or water that is not in contact with air.

HOW ARE PEOPLE EXPOSED TO TOLUENE?

Breathing: People are often exposed to high levels of toluene when they breathe vapors from paints, paint thinners, or glues. Breathing gasoline or car exhaust will also result in some exposure to toluene. People who live near industries using toluene may be exposed to the chemical in the air. If home water supplies are contaminated, people may inhale the chemical while washing, bathing or using water for other household purposes.

Some people intentionally inhale toluene to get "high." These people can be exposed to hazardous levels of the chemical.

Drinking/Eating: People may be exposed by drinking contaminated water, handling contaminated soils or touching their mouths or eating with dirty hands.

Touching: Although the chemical may irritate the skin, it passes through the skin slowly. People can be exposed to toluene when they touch the chemical, touch contaminated soil, or bathe in contaminated water.

DO STANDARDS EXIST FOR REGULATING TOLUENE?

Water: The Wisconsin drinking water standard is 343 parts per billion (ppb) of toluene. We suggest you stop drinking water that contains higher levels. If levels of toluene are very high in your water, you should avoid washing, bathing, or using the water for other purposes. Contact your local public health agency for more information specific to your situation.

Air: No standards exist for the amount of toluene allowed in the air of homes. We use a formula to convert work place limits to suggested home limits. Based on the formula, we recommend levels be no higher than 4 parts per million (ppm) of toluene in air. Most people can't smell toluene until levels reach 0.16 - 37 ppm. If you can smell the chemical, the level may be too high to be safe.

The Wisconsin Department of Natural Resources regulates the amount of toluene that can be released by industries.

WILL EXPOSURE TO TOLUENE RESULT IN HARMFUL HEALTH EFFECTS?

The following symptoms may occur immediately or shortly after exposure to levels over 100 ppm of toluene in air;

- Tiredness, dizziness, headache, loss of coordination or hearing, euphoria, insomnia
- Nausea
- Eye and nose irritation
- Rapid delay of reaction time, unconsciousness, and death at levels of 4,000 ppm

The worst effects of exposure to toluene have occurred in deliberate abusers of toluene. Most studies of workers exposed to moderate levels of toluene show no harmful health effects.

The following health effects can occur after several years of exposure to toluene:

Cancer: Research shows that toluene is unlikely to cause cancer.

Reproductive Effects: There are no indications toluene causes damage to reproductive organs. Toluene may affect the development of unborn babies.

Organ Systems: Damage to the brain, liver, bone marrow and kidneys can occur.

In general, chemicals affect the same organ systems in all people who are exposed. However, the seriousness of the effects may vary from person to person. A person's reaction depends on several things, including individual health, heredity, previous exposure to chemicals including medicines, and personal habits such as smoking or drinking.

It's also important to consider the length of exposure to the chemical; the amount of chemical exposure; and whether the chemical was inhaled, touched, or eaten.

CAN A MEDICAL TEST DETERMINE EXPOSURE TO TOLUENE?

The breakdown products of toluene, hipparic acid and cresol, can be measured in urine within 12 hours of a high level exposure. These measurements may not predict possible future health effects. Other medical tests may be helpful in determining damage to the nervous system, kidneys or liver.

Seek medical advice if you have any symptoms that you think may be related to chemical exposure.

This fact sheet summarizes information about this chemical and is not a complete listing of all possible effects. It does not refer to work exposure or emergency situations.

FOR MORE INFORMATION

- Poison Control Center, 800-815-8855
- Your local public health agency
- Division of Public Health, BEH, 1 West Wilson Street, Rm. 150, Madison, WI 53701-2659, (608) 266-1120 or Internet: www.dhfs.state.wi.us/eh/index.htm

Prepared by the
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(POH 4351 *Revised* 12/2000)

M-XYLENE

XLM

CAUTIONARY RESPONSE INFORMATION

Common Synonyms
1,3-Dimethylbenzene
Xylol

Watery liquid Colorless Sweet odor

Floats on water. Flammable, irritating vapor is produced.

Keep people away.
Shut off ignition sources and call fire department.
Avoid contact with liquid and vapor.
Notify local health and pollution control agencies.
Protect water intakes.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose, and throat.
If inhaled, will cause headache, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain
Collection Systems: Skim
Chemical and Physical Treatment: Burn
Clean shore line
Salvage waterfowl

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: 32; Aromatic Hydrocarbon
2.2 Formula: m-$C_6H_4(CH_3)_2$
2.3 IMO/UN Designation: 3.2/1307
2.4 DOT ID No.: 1307
2.5 CAS Registry No.: 108-38-3
2.6 NAERG Guide No.: 130
2.7 Standard Industrial Trade Classification: 51124

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
3.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma; can be fatal. Kidney and liver damage can occur.
3.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
3.4 TLV-TWA: 100 ppm
3.5 TLV-STEL: 150 ppm
3.6 TLV-Ceiling: Not listed.
3.7 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 g/kg
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: Kidney and liver damage.
3.10 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
3.11 Liquid or Solid Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
3.12 Odor Threshold: 0.05 ppm
3.13 IDLH Value: 900 ppm
3.14 OSHA PEL-TWA: 100 ppm
3.15 OSHA PEL-STEL: Not listed.
3.16 OSHA PEL-Ceiling: Not listed.
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: 81°F C.C.
4.2 Flammable Limits in Air: 1.1%-7.0%
4.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide
4.4 Fire Extinguishing Agents Not to Be Used: Water may be ineffective.
4.5 Special Hazards of Combustion Products: Not pertinent
4.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
4.7 Auto Ignition Temperature: 982°F
4.8 Electrical Hazards: Class I, Group D
4.9 Burning Rate: 5.8 mm/min.
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichometric Air to Fuel Ratio: 50.0 (calc.)
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): 13.0 (calc.)
4.14 Minimum Oxygen Concentration for Combustion (MOCC): Not listed

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: No reaction
5.2 Reactivity with Common Materials: No reaction
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity: 22 ppm/96 hr/bluegill/TL_m/fresh water
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): 0 lb/lb, 5 days; 0% (theor.), 8 days
6.4 Food Chain Concentration Potential: Currently not available
6.5 GESAMP Hazard Profile:
Bioaccumulation: 0
Damage to living resources: 3
Human Oral hazard: 1
Human Contact hazard: II
Reduction of amenities: XX

7. SHIPPING INFORMATION

7.1 Grades of Purity: Research: 99.99%; Pure: 99.9%; Technical: 99.2%
7.2 Storage Temperature: Ambient
7.3 Inert Atmosphere: No requirement
7.4 Venting: Open (flame arrester) or pressure-vacuum
7.5 IMO Pollution Category: C
7.6 Ship Type: 3
7.7 Barge Hull Type: Currently not available

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Flammable liquid
8.2 49 CFR Class: 3
8.3 49 CFR Package Group: III
8.4 Marine Pollutant: No
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue).....	2
Flammability (Red).....	3
Instability (Yellow).....	0

8.6 EPA Reportable Quantity: 1000 pounds
8.7 EPA Pollution Category: C
8.8 RCRA Waste Number: U239
8.9 EPA FWPCA List: Yes

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: 106.16
9.3 Boiling Point at 1 atm: 282°F = 138.9°C = 412.1°K
9.4 Freezing Point: –54.2°F = –47.9°C = 225.3°K
9.5 Critical Temperature: 650.8°F = 343.8°C = 617°K
9.6 Critical Pressure: 513.8 atm = 34.95 psia = 3.540 MN/m^2
9.7 Specific Gravity: 0.864 at 20°C (liquid)
9.8 Liquid Surface Tension: 28.6 dynes/cm = 0.0286 N/m at 20°C
9.9 Liquid Water Interfacial Tension: 36.4 dynes/cm = 0.0364 N/m at 30°C
9.10 Vapor (Gas) Specific Gravity: Not pertinent
9.11 Ratio of Specific Heats of Vapor (Gas): 1.071
9.12 Latent Heat of Vaporization: 147 Btu/lb = 81.9 cal/g = 3.43 X 10^5 J/kg
9.13 Heat of Combustion: –17,554 Btu/lb = –9752.4 cal/g = –408.31 X 10^5 J/kg
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: 26.01 cal/g
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: 0.34 psia

NOTES

M-XYLENE

XLM

9.20 SATURATED LIQUID DENSITY	
Temperature (degrees F)	Pounds per cubic foot
15	55.400
20	55.260
25	55.130
30	54.990
35	54.850
40	54.710
45	54.570
50	54.430
55	54.290
60	54.160
65	54.020
70	53.880
75	53.740
80	53.600
85	53.460
90	53.320
95	53.180
100	53.050

9.21 LIQUID HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
40	0.387
50	0.393
60	0.398
70	0.404
80	0.410
90	0.415
100	0.421
110	0.426
120	0.432
130	0.437
140	0.443
150	0.448
160	0.454
170	0.460
180	0.465
190	0.471
200	0.476
210	0.482

9.22 LIQUID THERMAL CONDUCTIVITY	
Temperature (degrees F)	British thermal unit inch per hour-square foot-F
35	0.962
40	0.953
45	0.944
50	0.935
55	0.926
60	0.917
65	0.908
70	0.899
75	0.890
80	0.881
85	0.873
90	0.864
95	0.855
100	0.846

9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Centipoise
15	0.938
20	0.898
25	0.862
30	0.827
35	0.794
40	0.764
45	0.735
50	0.708
55	0.682
60	0.658
65	0.635
70	0.613
75	0.592
80	0.572
85	0.554

9.24 SOLUBILITY IN WATER	
Temperature (degrees F)	Pounds per 100 pounds of water
	I
	N
	S
	O
	L
	U
	B
	L
	E

9.25 SATURATED VAPOR PRESSURE	
Temperature (degrees F)	Pounds per square inch
60	0.090
70	0.127
80	0.177
90	0.242
100	0.326
110	0.434
120	0.571
130	0.743
140	0.956
150	1.219
160	1.538
170	1.924
180	2.388
190	2.939
200	3.590
210	4.355
220	5.247
230	6.282
240	7.476
250	8.846
260	10.410

9.26 SATURATED VAPOR DENSITY	
Temperature (degrees F)	Pounds per cubic foot
60	0.00172
70	0.00238
80	0.00324
90	0.00435
100	0.00577
110	0.00754
120	0.00975
130	0.01247
140	0.01577
150	0.01977
160	0.02455
170	0.03023
180	0.03691
190	0.04473
200	0.05382
210	0.06431
220	0.07635
230	0.09009
240	0.10570
250	0.12330
260	0.14310

9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
0	0.247
25	0.260
50	0.273
75	0.286
100	0.299
125	0.311
150	0.324
175	0.336
200	0.348
225	0.360
250	0.371
275	0.383
300	0.394
325	0.406
350	0.417
375	0.427
400	0.438
425	0.449
450	0.459
475	0.469
500	0.479
525	0.489
550	0.499
575	0.508
600	0.517

O-XYLENE

XLO

CAUTIONARY RESPONSE INFORMATION

Common Synonyms
1,2-Dimethylbenzene
Xylol

Watery liquid Colorless Sweet odor

Floats on water. Flammable, irritating vapor is produced.

Keep people away.
Shut off ignition sources and call fire department.
Avoid contact with liquid and vapor.
Notify local health and pollution control agencies.
Protect water intakes.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause headache, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain
Collection Systems: Skim
Chemical and Physical Treatment: Burn
Clean shore line
Salvage waterfowl

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: 32; Aromatic Hydrocarbon
2.2 Formula: o-$C_6H_4(CH_3)_2$
2.3 IMO/UN Designation: 3.2/1307
2.4 DOT ID No.: 1307
2.5 CAS Registry No.: 95-47-6
2.6 NAERG Guide No.: 130
2.7 Standard Industrial Trade Classification: 51124

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
3.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma. Can be fatal. Kidney and liver damage can occur.
3.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
3.4 TLV-TWA: 100 ppm
3.5 TLV-STEL: 150 ppm
3.6 TLV-Ceiling: Not listed.
3.7 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: Kidney and liver damage.
3.10 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
3.11 Liquid or Solid Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
3.12 Odor Threshold: 0.05 ppm
3.13 IDLH Value: 900 ppm
3.14 OSHA PEL-TWA: 100 ppm
3.15 OSHA PEL-STEL: Not listed.
3.16 OSHA PEL-Ceiling: Not listed.
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: 90°F C.C.
4.2 Flammable Limits in Air: 0.9 - 6.7%
4.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide
4.4 Fire Extinguishing Agents Not to Be Used: Water may be ineffective.
4.5 Special Hazards of Combustion Products: Not pertinent
4.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
4.7 Auto Ignition Temperature: 869°F
4.8 Electrical Hazards: Class I, Group D
4.9 Burning Rate: 5.8 mm/min.
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichometric Air to Fuel Ratio: 50.0 (calc.)
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): 13.0 (calc.)
4.14 Minimum Oxygen Concentration for Combustion (MOCC): Not listed

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: No reaction
5.2 Reactivity with Common Materials: No reaction
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity: >100 mg/l/96 hr/D. magna/TL_m/fresh water
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): 0 lb/lb. 5 days; 2.5% (theor.), 8 days
6.4 Food Chain Concentration Potential: Currently not available
6.5 GESAMP Hazard Profile:
Bioaccumulation: 0
Damage to living resources: 3
Human Oral hazard: 1
Human Contact hazard: I
Reduction of amenities: X

7. SHIPPING INFORMATION

7.1 Grades of Purity: Research: 99.99%; Pure: 99.7%; Commercial: 95+%
7.2 Storage Temperature: Ambient
7.3 Inert Atmosphere: No reaction
7.4 Venting: Open (flame arrester) or pressure-vacuum
7.5 IMO Pollution Category: C
7.6 Ship Type: 3
7.7 Barge Hull Type: Currently not available

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Flammable liquid
8.2 49 CFR Class: 3
8.3 49 CFR Package Group: II
8.4 Marine Pollutant: No
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue).....	2
Flammability (Red).....	3
Instability (Yellow).....	0

8.6 EPA Reportable Quantity: 1000 pounds
8.7 EPA Pollution Category: C
8.8 RCRA Waste Number: U239
8.9 EPA FWPCA List: Yes

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: 106.16
9.3 Boiling Point at 1 atm: 291.9°F = 144.4°C = 417.6°K
9.4 Freezing Point: –13.3°F = –25.2°C = 248.0°K
9.5 Critical Temperature: 674.8°F = 357.1°C = 630.3°K
9.6 Critical Pressure: 541.5 atm = 36.84 psia = 3.732 MN/m^2
9.7 Specific Gravity: 0.880 at 20°C (liquid)
9.8 Liquid Surface Tension: 30.53 dynes/cm = 0.03053 N/m at 15.5°C
9.9 Liquid Water Interfacial Tension: 36.06 dynes/cm = 0.03606 N/m at 20°C
9.10 Vapor (Gas) Specific Gravity: Not pertinent
9.11 Ratio of Specific Heats of Vapor (Gas): 1.068
9.12 Latent Heat of Vaporization: 149 Btu/lb = 82.9 cal/g = 3.47 X 10^5 J/kg
9.13 Heat of Combustion: –17,558 Btu/lb = –9754.7 cal/g = –408.41 X 10^5 J/kg
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: 30.64 cal/g
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: 0.28 psia

NOTES

O-XYLENE

XLO

9.20 SATURATED LIQUID DENSITY	
Temperature (degrees F)	Pounds per cubic foot
15	56.460
20	56.330
25	56.190
30	56.050
35	55.910
40	55.770
45	55.630
50	55.490
55	55.360
60	55.220
65	55.080
70	54.940
75	54.800
80	54.660
85	54.520
90	54.380
95	54.250
100	54.110

9.21 LIQUID HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
35	0.389
40	0.391
45	0.394
50	0.396
55	0.398
60	0.400
65	0.402
70	0.404
75	0.406
80	0.408
85	0.411
90	0.413
95	0.415
100	0.417

9.22 LIQUID THERMAL CONDUCTIVITY	
Temperature (degrees F)	British thermal unit inch per hour-square foot-F
35	1.043
40	1.035
45	1.027
50	1.018
55	1.010
60	1.002
65	0.993
70	0.985
75	0.977
80	0.969
85	0.960
90	0.952
95	0.944
100	0.935

9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Centipoise
15	1.328
20	1.263
25	1.202
30	1.145
35	1.092
40	1.042
45	0.995
50	0.952
55	0.911
60	0.873
65	0.836
70	0.802
75	0.770
80	0.740
85	0.712

9.24 SOLUBILITY IN WATER	
Temperature (degrees F)	Pounds per 100 pounds of water
	I
	N
	S
	O
	L
	U
	B
	L
	E

9.25 SATURATED VAPOR PRESSURE	
Temperature (degrees F)	Pounds per square inch
60	0.071
70	0.101
80	0.141
90	0.194
100	0.263
110	0.352
120	0.465
130	0.609
140	0.787
150	1.007
160	1.277
170	1.605
180	1.999
190	2.469
200	3.028
210	3.686
220	4.456
230	5.352
240	6.389
250	7.581
260	8.947

9.26 SATURATED VAPOR DENSITY	
Temperature (degrees F)	Pounds per cubic foot
60	0.00135
70	0.00188
80	0.00258
90	0.00349
100	0.00464
110	0.00611
120	0.00794
130	0.01021
140	0.01298
150	0.01634
160	0.02038
170	0.02520
180	0.03090
190	0.03759
200	0.04539
210	0.05443
220	0.06484
230	0.07674
240	0.09030
250	0.10560
260	0.12290

9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
0	0.261
25	0.274
50	0.287
75	0.299
100	0.311
125	0.323
150	0.335
175	0.347
200	0.358
225	0.370
250	0.381
275	0.392
300	0.403
325	0.414
350	0.424
375	0.435
400	0.445
425	0.455
450	0.465
475	0.475
500	0.485
525	0.494
550	0.504
575	0.513
600	0.522

P-XYLENE

XLP

CAUTIONARY RESPONSE INFORMATION

Common Synonyms
1,4-Dimethylbenzene
Xylol

Watery liquid Colorless Sweet odor

Floats on water. Flammable, irritating vapor is produced. Freezing point is 56°F.

Keep people away.
Shut off ignition sources and call fire department.
Avoid contact with liquid and vapor.
Notify local health and pollution control agencies.
Protect water intakes.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain
Collection Systems: Skim
Chemical and Physical Treatment: Burn
Clean shore line
Salvage waterfowl

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: 32; Aromatic Hydrocarbon
2.2 Formula: p-$C_6H_4(CH_3)_2$
2.3 IMO/UN Designation: 3.2/1307
2.4 DOT ID No.: 1307
2.5 CAS Registry No.: 106-42-3
2.6 NAERG Guide No.: 130
2.7 Standard Industrial Trade Classification: 51124

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
3.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma. Can be fatal. Kidney and liver damage can occur.
3.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
3.4 TLV-TWA: 100 ppm
3.5 TLV-STEL: 150 ppm
3.6 TLV-Ceiling: Not listed.
3.7 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: Kidney and liver damage.
3.10 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
3.11 Liquid or Solid Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
3.12 Odor Threshold: 0.05 ppm
3.13 IDLH Value: 900 pmm
3.14 OSHA PEL-TWA: 100 ppm
3.15 OSHA PEL-STEL: Not listed.
3.16 OSHA PEL-Ceiling: Not listed.
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: 81°F C.C.
4.2 Flammable Limits in Air: 1.1%-7.0%
4.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide
4.4 Fire Extinguishing Agents Not to Be Used: Water may be ineffective.
4.5 Special Hazards of Combustion Products: Not pertinent
4.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
4.7 Auto Ignition Temperature: 984°F
4.8 Electrical Hazards: Class I, Group D
4.9 Burning Rate: 5.8 mm/min.
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichometric Air to Fuel Ratio: 50.0 (calc.)
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): 13.0 (calc.)
4.14 Minimum Oxygen Concentration for Combustion (MOCC): Not listed

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: No reaction
5.2 Reactivity with Common Materials: No reaction
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity: 22 ppm/96 hr/bluegill/TL_m/fresh water
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): 0 lb/lb in 5 days
6.4 Food Chain Concentration Potential: Currently not available
6.5 GESAMP Hazard Profile:
Bioaccumulation: 0
Damage to living resources: 3
Human Oral hazard: 1
Human Contact hazard: I
Reduction of amenities: X

7. SHIPPING INFORMATION

7.1 Grades of Purity: Research: 99.99%; Pure: 99.8%; Technical: 99.0%
7.2 Storage Temperature: Ambient
7.3 Inert Atmosphere: No requirement
7.4 Venting: Open (flame arrester) or pressure-vacuum
7.5 IMO Pollution Category: C
7.6 Ship Type: 3
7.7 Barge Hull Type: Currently not available

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Flammable liquid
8.2 49 CFR Class: 3
8.3 49 CFR Package Group: III
8.4 Marine Pollutant: No
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue).....	2
Flammability (Red).....	3
Instability (Yellow).....	0

8.6 EPA Reportable Quantity: 100 pounds
8.7 EPA Pollution Category: B
8.8 RCRA Waste Number: U239
8.9 EPA FWPCA List: Yes

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: 106.16
9.3 Boiling Point at 1 atm: 280.9°F = 138.3°C = 411.5°K
9.4 Freezing Point: 55.9°F = 13.3°C = 286.5°K
9.5 Critical Temperature: 649.4°F = 343.0°C = 616.2°K
9.6 Critical Pressure: 509.4 atm = 34.65 psia = 3.510 MN/m^2
9.7 Specific Gravity: 0.861 at 20°C (liquid)
9.8 Liquid Surface Tension: 28.3 dynes/cm = 0.0283 N/m at 20°C
9.9 Liquid Water Interfacial Tension: 37.8 dynes/cm = 0.0378 N/m at 20°C
9.10 Vapor (Gas) Specific Gravity: Not pertinent
9.11 Ratio of Specific Heats of Vapor (Gas): 1.071
9.12 Latent Heat of Vaporization: 150 Btu/lb = 81 cal/g = 3.4 X 10^5 J/kg
9.13 Heat of Combustion: –17,559 Btu/lb = –9754.7 cal/g = –408.41 X 10^5 J/kg
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: 37.83 cal/g
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: 0.34 psia

NOTES

P-XYLENE

XLP

9.20 SATURATED LIQUID DENSITY	
Temperature (degrees F)	Pounds per cubic foot
60	53.970
65	53.830
70	53.690
75	53.550
80	53.410
85	53.270
90	53.140
95	53.000
100	52.860
105	52.720
110	52.580
115	52.440
120	52.300

9.21 LIQUID HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
60	0.412
70	0.418
80	0.424
90	0.429
100	0.435
110	0.440
120	0.446
130	0.451
140	0.457
150	0.462
160	0.468
170	0.474
180	0.479
190	0.485
200	0.490
210	0.496
220	0.501
230	0.507
240	0.512
250	0.518
260	0.524
270	0.529
280	0.535

9.22 LIQUID THERMAL CONDUCTIVITY	
Temperature (degrees F)	British thermal unit inch per hour-square foot-F
60	0.935
65	0.928
70	0.921
75	0.914
80	0.907
85	0.900
90	0.892
95	0.885
100	0.878

9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Centipoise
60	0.678
65	0.654
70	0.631
75	0.610
80	0.590
85	0.571
90	0.552
95	0.535
100	0.519
105	0.503
110	0.488
115	0.474
120	0.460

9.24 SOLUBILITY IN WATER	
Temperature (degrees F)	Pounds per 100 pounds of water
	I
	N
	S
	O
	L
	U
	B
	L
	E

9.25 SATURATED VAPOR PRESSURE	
Temperature (degrees F)	Pounds per square inch
60	0.096
70	0.135
80	0.187
90	0.255
100	0.343
110	0.456
120	0.599
130	0.777
140	0.998
150	1.270
160	1.600
170	1.998
180	2.475
190	3.041
200	3.710
210	4.493
220	5.407
230	6.465
240	7.683
250	9.080
260	10.670

9.26 SATURATED VAPOR DENSITY	
Temperature (degrees F)	Pounds per cubic foot
60	0.00183
70	0.00252
80	0.00343
90	0.00459
100	0.00607
110	0.00792
120	0.01022
130	0.01303
140	0.01646
150	0.02059
160	0.02553
170	0.03138
180	0.03826
190	0.04629
200	0.05561
210	0.06636
220	0.07867
230	0.09270
240	0.10860
250	0.12650
260	0.14670

9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
0	0.246
25	0.259
50	0.272
75	0.285
100	0.297
125	0.309
150	0.321
175	0.333
200	0.345
225	0.357
250	0.368
275	0.380
300	0.391
325	0.402
350	0.413
375	0.424
400	0.435
425	0.445
450	0.456
475	0.466
500	0.476
525	0.486
550	0.496
575	0.505
600	0.515

POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)

Also known as: Polynuclear Aromatic Hydrocarbons, PNA, Polyaromatic Hydrocarbons
Examples: Benzo(a)pyrene, Benzanthracene, Benzo(b)fluoranthene, Fluoranthene, Naphthalene

WHAT ARE PAHs?

PAHs are a group of approximately 10,000 compounds, a few of which are listed above. Most PAHs in the environment are from incomplete burning of carbon-containing materials like oil, wood, garbage or coal. Many useful products such as mothballs, blacktop, and creosote wood preservatives contain PAHs. They are also found at low concentrations in some special-purpose skin creams and anti-dandruff shampoos that contain coal tars.

Automobile exhaust, industrial emissions and smoke from burning wood, charcoal and tobacco contain high levels of PAHs. In general, more PAHs form when materials burn at low temperatures, such as in wood fires or cigarettes. High-temperature furnaces produce fewer PAHs.

Fires can form fine PAH particles. They bind to ash particles and can move long distances through the air. Some PAHs can dissolve in water. PAHs can enter groundwater from ash, tar, or creosote that is improperly disposed in landfills.

HOW ARE PEOPLE EXPOSED TO PAHs?

Breathing: Most people are exposed to PAHs when they breathe smoke, auto emissions or industrial exhausts. Most exhausts contain many different PAH compounds. People with the highest exposures are smokers, people who live or work with smokers, roofers, road builders and people who live near major highways or industrial sources.

Drinking/Eating: Charcoal-broiled foods, especially meats, are a source of some PAH exposure. Shellfish living in contaminated water may be another major source of exposure. PAHs may be in groundwater near disposal sites where construction wastes or ash are buried; people may be exposed by drinking this water. Vegetables do not take up significant amounts of PAHs that are in soil.

Touching: PAH can be absorbed through skin. Exposure can come from handling contaminated soil or bathing in contaminated water. Low levels of these chemicals may be absorbed when a person uses medicated skin cream or shampoo containing PAHs.

DO STANDARDS EXIST FOR REGULATING PAHs?

Water: Wisconsin has established drinking water standards for five PAHs: Anthracene - 3,000 parts per billion (ppb), Benzo(a)pyrene - 0.2 ppb, Benzo(b)fluoranthene - 0.2 ppb, Fluoranthene - 400 ppb and Fluorene - 400 ppb. We suggest you stop drinking water containing more than these amounts. If other PAHs are found in your drinking water, contact your local public health agency for advice.

Air: No standards exist for the amount of PAHs allowed in the air of homes. We use a formula to convert workplace limits to suggested home limits. Based on the formula, we recommend levels of PAHs in air be no higher than 0.004 parts per million (ppm).

The Wisconsin Department of Natural Resources regulates the amount of several PAHs that can be released by industries.

WILL EXPOSURE TO PAHs RESULT IN HARMFUL HEALTH EFFECTS?

The effects of breathing high concentrations of PAHs have not been studied. However, PAHs may be attached to dust or ash causing lung irritation. Skin contact with PAHs may cause redness, blistering, and peeling.

The following health effects can occur after several years of exposure to PAHs:

Cancer: Benzo(a)pyrene, a common PAH, is shown to cause lung and skin cancer in laboratory animals. Other PAHs are not known to have this effect. Extracts of various types of smoke containing PAHs caused lung tumors in laboratory animals. Cigarette smoke will cause lung cancer.

Reproductive Effects: Reproductive problems and problems in unborn babies' development have occurred in laboratory animals that were exposed to benzo(a)pyrene. Other PAHs have not been studied enough to determine whether they cause reproductive problems.

Organ Systems: A person's lungs, liver, skin, and kidneys can be damaged by exposure.

In general, chemicals affect the same organ systems in all people who are exposed. However, the seriousness of the effects may vary from person to person.

A person's reaction depends on several things, including individual health, heredity, previous exposure to chemicals including medicines, and personal habits such as smoking or drinking.

It's also important to consider the length of exposure to the chemical; the amount of chemical exposure; and whether the chemical was inhaled, touched, or eaten.

CAN A MEDICAL TEST DETERMINE EXPOSURE TO PAHs?

Many PAHs can be detected in blood or urine soon after exposure. Tests for these compounds are not routine and can only be performed using special equipment not usually found in doctor's offices. People who think they may have been exposed to PAHs for a long time should contact their physician. Blood tests of liver and kidney function are available. People exposed to PAHs in air may want to ask their doctor to consider having lung function tests done.

Seek medical advice if you have any symptoms that you think may be related to chemical exposure.

This fact sheet summarizes information about this chemical and is not a complete listing of all possible effects. It does not refer to work exposure or emergency situations.

FOR MORE INFORMATION

- Poison Control Center, 800-815-8855
- Your local public health agency
- Division of Public Health, BEH, 1 West Wilson Street, Rm. 150, Madison, WI 53701-2659, (608) 266-1120 or Internet: www.dhfs.state.wi.us/eh/index.htm

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U.S. Department of Health and Human Services.

(POH 4606 *Revised* 12/2000)

NAPHTHA: COAL TAR

NCT

CAUTIONARY RESPONSE INFORMATION

Common Synonyms			
Mixture of benzene, toluene, xylenes	Watery liquid	Colorless to pale yellow	Gasoline-like odor
	Floats on water. Irritating vapor is produced.		

Keep people away.
Avoid inhalation.
Shut off ignition sources and call fire department.
Avoid contact with liquid and vapor.
Stay upwind and use water spray to ``knock down'' vapor.
Notify local health and pollution control agencies.
Protect water intakes.

Fire

Combustible.
Extinguish with foam, dry chemical or carbon dioxide.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness, headache, difficult breathing or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea or vomiting.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain
Collection Systems: Skim
Chemical and Physical Treatment: Burn
Clean shore line
Salvage waterfowl

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: 33; Miscellaneous Hydrocarbon Mixtures
2.2 Formula: Currently not available
2.3 IMO/UN Designation: 3.2/2553
2.4 DOT ID No.: 1268
2.5 CAS Registry No.: MX8030-31-7
2.6 NAERG Guide No.: 128
2.7 Standard Industrial Trade Classification: 33429

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Hydrocarbon vapor canister or air pack; plastic gloves; goggles or face shield.
3.2 Symptoms Following Exposure: Primarily a narcotic, causing unconsciousness in high concentrations. The symptoms of acute benzene poisoning are not likely, since the compound has components other than benzene.
3.3 Treatment of Exposure: Remove from exposure. Support respiration. Call physician.
3.4 TLV-TWA: 400 ppm
3.5 TLV-STEL: Not listed.
3.6 TLV-Ceiling: Not listed.
3.7 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: Leukemia
3.10 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
3.11 Liquid or Solid Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause a smarting and reddening of the skin.
3.12 Odor Threshold: 4.68 ppm
3.13 IDLH Value: 1,000 ppm
3.14 OSHA PEL-TWA: 100 ppm
3.15 OSHA PEL-STEL: Not listed.
3.16 OSHA PEL-Ceiling: Not listed.
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: 107°F C.C.
4.2 Flammable Limits in Air: Currently not available
4.3 Fire Extinguishing Agents: Foam, carbon dioxide, or dry chemical
4.4 Fire Extinguishing Agents Not to Be Used: Not pertinent
4.5 Special Hazards of Combustion Products: Not pertinent
4.6 Behavior in Fire: Not pertinent
4.7 Auto Ignition Temperature: 900–950°F
4.8 Electrical Hazards: Class I, Group D
4.9 Burning Rate: 4 mm/min.
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichometric Air to Fuel Ratio: Not pertinent.
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): Not pertinent.
4.14 Minimum Oxygen Concentration for Combustion (MOCC): Not listed

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: No reaction
5.2 Reactivity with Common Materials: No reaction
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity: Currently not available
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): Currently not available
6.4 Food Chain Concentration Potential: None
6.5 GESAMP Hazard Profile: Not listed

7. SHIPPING INFORMATION

7.1 Grades of Purity: Purity varies with coal used and distillation range taken.
7.2 Storage Temperature: Ambient
7.3 Inert Atmosphere: No requirement
7.4 Venting: Open (flame arrester)
7.5 IMO Pollution Category: B
7.6 Ship Type: 3
7.7 Barge Hull Type: 3

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Flammable liquid
8.2 49 CFR Class: 3
8.3 49 CFR Package Group: I
8.4 Marine Pollutant: Yes
8.5 NFPA Hazard Classification: Not listed
8.6 EPA Reportable Quantity: Not listed.
8.7 EPA Pollution Category: Not listed.
8.8 RCRA Waste Number: Not listed
8.9 EPA FWPCA List: Not listed

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: Not pertinent
9.3 Boiling Point at 1 atm: 200–500°F = 93–260°C = 366-533°K
9.4 Freezing Point: Not pertinent
9.5 Critical Temperature: Not pertinent
9.6 Critical Pressure: Not pertinent
9.7 Specific Gravity: 0.86–0.88 at 20°C (liquid)
9.8 Liquid Surface Tension: (est.) 20 dynes/cm = 0.020 N/m at 20°C
9.9 Liquid Water Interfacial Tension: (est.) 45 dynes/cm = 0.045 N/m at 20°C
9.10 Vapor (Gas) Specific Gravity: Currently not available
9.11 Ratio of Specific Heats of Vapor (Gas): (est.) 1.030
9.12 Latent Heat of Vaporization: (est.) 101 Btu/lb = 56.2 cal/g = 2.35 X 10^5 J/kg
9.13 Heat of Combustion: (est.) –18,200 Btu/lb = –10,100 cal/g = –424 X 10^5 J/kg
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: Currently not available
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: 0.13 psia

NOTES

NAPHTHA: COAL TAR

NCT

9.20 SATURATED LIQUID DENSITY		9.21 LIQUID HEAT CAPACITY		9.22 LIQUID THERMAL CONDUCTIVITY		9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit inch per hour-square foot-F	Temperature (degrees F)	Centipoise
50	53.680	50	0.478	50	1.040	50	9.343
52	53.680	52	0.478	52	1.040	52	8.841
54	53.680	54	0.478	54	1.040	54	8.370
56	53.680	56	0.478	56	1.040	56	7.927
58	53.680	58	0.478	58	1.040	58	7.511
60	53.680	60	0.478	60	1.040	60	7.119
62	53.680	62	0.478	62	1.040	62	6.751
64	53.680	64	0.478	64	1.040	64	6.404
66	53.680	66	0.478	66	1.040	66	6.078
68	53.680	68	0.478	68	1.040	68	5.770
70	53.680	70	0.478	70	1.040	70	5.481
72	53.680	72	0.478	72	1.040	72	5.207
74	53.680	74	0.478	74	1.040	74	4.950
76	53.680	76	0.478	76	1.040	76	4.707
78	53.680	78	0.478	78	1.040	78	4.477
80	53.680	80	0.478	80	1.040	80	4.260
82	53.680	82	0.478	82	1.040	82	4.056
84	53.680	84	0.478	84	1.040	84	3.862
86	53.680	86	0.478	86	1.040	86	3.679
88	53.680	88	0.478	88	1.040	88	3.506
90	53.680	90	0.478	90	1.040	90	3.342
92	53.680	92	0.478	92	1.040	92	3.187
94	53.680	94	0.478	94	1.040	94	3.040
96	53.680	96	0.478	96	1.040	96	2.901
98	53.680	98	0.478	98	1.040	98	2.770
100	53.680	100	0.478	100	1.040	100	2.645

9.24 SOLUBILITY IN WATER		9.25 SATURATED VAPOR PRESSURE		9.26 SATURATED VAPOR DENSITY		9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	I N S O L U B L E	90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340	0.094 0.124 0.163 0.211 0.272 0.347 0.440 0.553 0.691 0.856 1.054 1.290 1.569 1.897 2.281 2.728 3.247 3.846 4.535 5.323 6.221 7.241 8.394 9.695 11.160 12.790		N O T P E R T I N E N T		C U R R E N T L Y N O T A V A I L A B L E

CYANIDE

Chemical reference numbers (CAS) of common forms: Cyanide 57-12-5, Zinc Cyanide 557-21-1, Sodium Cyanide 143-33-9, Potassium Cyanide 151-50-8, Hydrogen Cyanide 74-90-8

WHAT IS CYANIDE?

Cyanide is very poisonous. Cyanide can exist as a gas, liquid or white crystal powder. Cyanide is used in the electroplating industry, in metal cleaning operations, and as an industrial bug killer. Breathing the gas, eating the liquid or solid forms can make people suddenly lose consciousness or cause death.

There are no common uses of cyanide in the home. Most cyanide in the environment results from industrial processes and from improper waste disposal.

HOW ARE PEOPLE EXPOSED TO CYANIDE?

Breathing: Cyanide gas can be found in industrial emissions and car exhaust, cigarette smoke and certain papers and plastics as they burn. It is also possible to breathe or eat cyanide dust when working with cyanide powder. If people use a contaminated water supply, they can breathe cyanide when they cook or shower with the water.

Drinking/Eating: Cyanide is sometimes found in contaminated drinking water. People can be exposed when they drink contaminated water. People who handle contaminated soil may be exposed when they eat or touch their mouths with dirty hands.

Touching: Cyanide can enter the body through skin when people handle the chemical, contaminated soil or contaminated water. People can be exposed to cyanide if they wash or bathe with contaminated water.

DO STANDARDS EXIST FOR REGULATING CYANIDE?

Water: The federal drinking water standard for cyanide is set at 200 parts per billion (ppb). We suggest you stop drinking water containing more than 200 ppb of cyanide.

Air: No standards exist for the amount of cyanide allowed in the air of homes. We use a formula to convert workplace limits to suggested home limits. Based on the formula, we recommend cyanide levels be no higher than 90 ppb. Most people can't smell cyanide until levels reach 600 ppb. Cyanide compounds smell like bitter almonds to some people, while others cannot smell them at all. If you can smell the chemical, the level is too high to be safe.

The Wisconsin Department of Natural Resources regulates the amount of cyanide that can be released by industries.

WILL EXPOSURE TO CYANIDE RESULT IN HARMFUL HEALTH EFFECTS?

The following health effects are described in cases of suicide or accidental exposure to high levels of cyanide compounds. These effects are not expected following low-dose exposures:

- Irritation of skin and mucous membranes (causing redness or flushing of skin)
- Headaches, dizziness and loss of coordination
- Nausea and vomiting
- Rapid, deep breathing or gasping
- Rapid pulse rate and increased blood pressure
- Muscle spasms and convulsions
- Loss of consciousness and death.

The following health effects can occur after several years of exposure to low levels of cyanide:

Cancer: No studies show a relationship between exposure to cyanide and the development of cancer.

Reproductive Effects: Studies of laboratory animals show exposure to cyanide resulted in birth defects.

Organ Systems: Cyanide can cause nerve damage affecting hearing, vision, and muscle coordination. Damage to the thyroid gland is also possible, resulting in changes of metabolism in adults and slowing growth or development in children.

In general, chemicals affect the same organ systems in all people who are exposed. A person's reaction depends on several things, including individual health, heredity, previous exposure to chemicals including medicines, and personal habits such as smoking or drinking.

It's also important to consider the length of exposure to the chemical; the amount of chemical exposure; and whether the chemical was inhaled, touched, or eaten.

CAN A MEDICAL TEST DETERMINE EXPOSURE TO CYANIDE?

Doctors can test urine for "thiocyanate" shortly after exposure to cyanide. Blood levels of cyanide can indicate recent exposure. Cigarette smokers generally have higher levels of cyanide-related compounds in their bodies than non-smokers.

Seek medical advice if you have any symptoms that you think may be related to chemical exposure.

This fact sheet summarizes information about this chemical and is not a complete listing of all possible effects. It does not refer to work exposure or emergency situations.

FOR MORE INFORMATION

- Poison Control Center, 800-815-8855
- Your local public health agency
- Division of Public Health, BEH, 1 West Wilson Street, Rm. 150, Madison, WI 53701-2659, (608) 266-1120 or Internet: www.dhfs.state.wi.us/eh/index.htm

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Public Health Service,
U.S. Department of Health and Human Services.

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POLYCHLORINATED BIPHENYL

PCB

CAUTIONARY RESPONSE INFORMATION

Common Synonyms			
Arochlor Chlorinated biphenyl Halogenated waxes PCB Polychloropolyphenyls	Oily liquid to solid powder Sinks in water.	Light yellow liquid, or white powder	Weak odor

Notify local health and pollution control agencies.
Protect water intakes.
Keep people away.
Avoid contact with liquid and solid.
Call fire department.

Fire	Combustible. Extinguish with water, foam, dry chemical, or carbon dioxide.
Exposure	CALL FOR MEDICAL AID. LIQUID OR SOLID Irritating to skin and eyes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water.
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain
Collection Systems: Pump; Dredge
Clean shore line

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: Not listed.
2.2 Formula: $(C_{12}H_{10-x})Cl_x$
2.3 IMO/UN Designation: Not listed
2.4 DOT ID No.: 2315
2.5 CAS Registry No.: 1336-36-3
2.6 NAERG Guide No.: 171
2.7 Standard Industrial Trade Classification: 51139

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Gloves and protective garments.
3.2 Symptoms Following Exposure: Acne from skin contact.
3.3 Treatment of Exposure: SKIN: wash with soap and water.
3.4 TLV-TWA: Not listed.
3.5 TLV-STEL: Not listed.
3.6 TLV-Ceiling: Not listed.
3.7 Toxicity by Ingestion: Grade 2; oral rat LD_{50} = 3980 mg/kg
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: Causes chromosomal abnormalities in rats, birth defects in birds
3.10 Vapor (Gas) Irritant Characteristics: Vapors cause severe irritation of eyes and throat and cause eye and lung injury. They cannot be tolerated even at low concentrations.
3.11 Liquid or Solid Characteristics: Contact with skin may cause irritation.
3.12 Odor Threshold: Currently not available
3.13 IDLH Value: Not listed.
3.14 OSHA PEL-TWA: Not listed.
3.15 OSHA PEL-STEL: Not listed.
3.16 OSHA PEL-Ceiling: Not listed.
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: >286°F
4.2 Flammable Limits in Air: Currently not available
4.3 Fire Extinguishing Agents: Water, foam, dry chemical, or carbon dioxide
4.4 Fire Extinguishing Agents Not to Be Used: Not pertinent
4.5 Special Hazards of Combustion Products: Irritating gases are generated in fires.
4.6 Behavior in Fire: Not pertinent
4.7 Auto Ignition Temperature: Currently not available
4.8 Electrical Hazards: Not pertinent
4.9 Burning Rate: Currently not available
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichometric Air to Fuel Ratio: Not pertinent.
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): Not pertinent.
4.14 Minimum Oxygen Concentration for Combustion (MOCC): Not listed

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: No reaction
5.2 Reactivity with Common Materials: No reaction
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity:
0.278 ppm/96 hr/bluegill/TL_m/fresh water
0.005 ppm/336-1080 hr/pinfish/TL_m/salt water
6.2 Waterfowl Toxicity: LD_{50} 2000 ppm (mallard duck)
6.3 Biological Oxygen Demand (BOD): Very low
6.4 Food Chain Concentration Potential: High
6.5 GESAMP Hazard Profile:
Bioaccumulation: +
Damage to living resources: 4
Human Oral hazard: 1
Human Contact hazard: II
Reduction of amenities: XX

7. SHIPPING INFORMATION

7.1 Grades of Purity: 11 grades (some liquid, some solids) which differ primarily in their chlorine content (20%-68% by weight)
7.2 Storage Temperature: Ambient
7.3 Inert Atmosphere: No requirement
7.4 Venting: Open
7.5 IMO Pollution Category: Currently not available
7.6 Ship Type: Currently not available
7.7 Barge Hull Type: Currently not available

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Class 9
8.2 49 CFR Class: 9
8.3 49 CFR Package Group: II
8.4 Marine Pollutant: Yes
8.5 NFPA Hazard Classification: Not listed
8.6 EPA Reportable Quantity: 1 pound
8.7 EPA Pollution Category: X
8.8 RCRA Waste Number: Not listed
8.9 EPA FWPCA List: Yes

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Solid
9.2 Molecular Weight: Not pertinent
9.3 Boiling Point at 1 atm: Very high
9.4 Freezing Point: Not pertinent
9.5 Critical Temperature: Not pertinent
9.6 Critical Pressure: Not pertinent
9.7 Specific Gravity: 1.3–1.8 at 20°C (liquid)
9.8 Liquid Surface Tension: Not pertinent
9.9 Liquid Water Interfacial Tension: Not pertinent
9.10 Vapor (Gas) Specific Gravity: Not pertinent
9.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
9.12 Latent Heat of Vaporization: Not pertinent
9.13 Heat of Combustion: Not pertinent
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: Currently not available
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: Currently not available

NOTES

POLYCHLORINATED BIPHENYL

PCB

9.20 SATURATED LIQUID DENSITY		9.21 LIQUID HEAT CAPACITY		9.22 LIQUID THERMAL CONDUCTIVITY		9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit inch per hour-square foot-F	Temperature (degrees F)	Centipoise
68	81.150		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT
69	81.150						
70	81.150						
71	81.150						
72	81.150						
73	81.150						
74	81.150						
75	81.150						
76	81.150						
77	81.150						
78	81.150						
79	81.150						
80	81.150						
81	81.150						
82	81.150						
83	81.150						
84	81.150						
85	81.150						

9.24 SOLUBILITY IN WATER		9.25 SATURATED VAPOR PRESSURE		9.26 SATURATED VAPOR DENSITY		9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	INSOLUBLE		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

POLYCHLORINATED BIPHENYLS (PCBs)

Also known as: Aroclor, Chlorinated Biphenyls, Kaneclor
Chemical reference number (CAS): 1336-36-3

WHAT ARE PCBs?

PCBs are a group of 209 different compounds. PCBs are man-made and have no smell. They are yellow, oily liquids that don't easily burn. There are no natural sources of PCBs.

Companies in the United States first made PCBs in 1929. They've been used as coolants in electrical equipment, metal-cutting oils, microscope lens oils, and in inks, dyes, and carbonless copy paper.

In 1977, the U.S. Environmental Protection Agency (EPA) banned the use of PCBs. The EPA was concerned about the harmful effects of PCBs. For example, PCBs can accumulate in the environment. PCBs may be present in old fluorescent light fixtures and parts of appliances made before 1978.

PCBs break down very slowly and can be carried long distances in the air, in rivers, lakes and oceans. PCBs can build up over time in the fat of people and animals. Recent studies found that most people have traces of PCBs in their body fat. PCBs can build-up in the food chain. For example, fish can have PCB levels in their fatty tissues that are much higher than the surrounding water.

HOW ARE PEOPLE EXPOSED TO PCBs

Drinking/Eating: For most people, eating fish or other seafood caught from polluted water is the main way in which they are exposed to PCBs.

Women who are pregnant or plan to have children should be especially cautious about eating contaminated fish. When people eat contaminated food over many years, PCBs can build up in their body fat. When people lose weight or breastfeed, their bodies use stored fat and put stored PCBs back into their blood. Babies may be exposed to PCBs in breast milk from mothers who often eat PCB contaminated fish.

Researchers have found high levels of PCBs in several types of fish, shellfish, marine mammals and waterfowl. In general, older animals living in polluted areas have the highest levels. State advisories are available for people who eat sport-caught fish and waterfowl. For more information, contact your regional Wisconsin Department of Natural Resources (DNR) office or call (608) 266-1877.

Touching: People can be exposed to PCBs in places where these chemicals were used, spilled, or thrown away. PCBs can be absorbed through skin during handling of the chemicals, contaminated soil or other contaminated items.

Breathing: Inhalation of PCB vapors or air is a minor source of contamination.

DO STANDARDS EXIST FOR REGULATING PCBs?

Food: The U.S. Food and Drug Administration (FDA) suggests not eating fish containing more than 2 parts per million of PCBs. This guidance assumes that a person eats two 8-ounce servings of fish per month, for every month of the year.

Water: The state and federal drinking water standard for PCBs are both set at 0.5 parts per billion (ppb). The Wisconsin groundwater standard is 0.03 ppb. Wisconsin's standard is to protect people against the possible cancer-causing effects of PCBs and the effects PCBs have on infants. We suggest you stop drinking water containing more than 0.03 ppb of PCBs.

WILL EXPOSURE TO PCBs RESULT IN HARMFUL HEALTH EFFECTS?

Researchers have found PCBs cause a number of harmful health effects. Exposure to high levels of PCBs, as might occur as a result of a chemical spill, can cause changes in the immune system and in liver function. The following health effects can occur after several years of exposure to PCBs:

Cancer: PCBs cause liver cancer in laboratory animals and may cause cancer in humans.

Reproductive Effects: Some limited animal and human studies suggest PCBs can effect reproduction and the development of unborn babies. Researchers have noted learning and memory problems in some children who were exposed to PCBs before birth.

Immunity: Animal studies show the immune system can be affected by PCBs.

Organ Systems: PCB exposure can cause liver damage.

In general, chemicals affect the same organ systems in all people who are exposed. However, the seriousness of the effects may vary from person to person.

Each person's reaction depends on several things, including individual health, heredity, previous exposure to chemicals including medicines, and personal habits such as smoking or drinking.

It is also important to consider the length of exposure to the chemical; the amount of chemical exposure; and whether the chemical was inhaled, touched, or eaten.

CAN A MEDICAL TEST DETERMINE EXPOSURE TO PCBs?

Doctors can use blood tests to evaluate exposure to PCBs. This type of blood test is expensive and not always locally available. Testing can also detect PCBs in human fat or breast milk. Most testing of this type has been done for research purposes. Liver function tests may be helpful in determining damage from exposure.

Seek medical advice if you have any symptoms that you think may be related to exposure.

This fact sheet summarizes information about this chemical and is not a complete listing of all possible effects. It does not refer to work exposure or emergency situations.

FOR MORE INFORMATION

- Poison Control Center, 800-815-8855
- Your local public health agency
- Division of Public Health, BEH, 1 West Wilson Street, Rm. 150, Madison, WI 53701-2659, (608) 266-1120 or Internet: www.dhfs.state.wi.us/eh/index.htm

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(POH 4607 *Revised* 12/2000)

MATERIAL SAFETY DATA SHEET

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SECTION A - PRODUCT INFORMATION

TRADE NAME : ARSENIC METAL:
MBE CHARGES, ARSENIC CHUNK & GRANULE
REVISION DATE : NOVEMBER 16, 2007

CAS NUMBER : 7440-38-2
SYNONYMS : METALLIC ARSENIC; GREY ARSENIC; ARSENIA
CHEMICAL FAMILY : METALS - GROUP 5a
FORMULA : As

SECTION B - HAZARDOUS COMPONENTS

COMPONENT	CAS NO.	%	PEL/TLV
ARSENIC METAL (As)	7440-38-2	100	0.01mg/m^3 ACGIH TWA AS As 0.01mg/m^3 OSHA TWA, INORGANIC COMPOUNDS AS As (SEE 29 CFR 1910.1018) 0.5 mg/m^3 OSHA TWA, ORGANIC COMPOUNDS AS As 0.002 mg/m^3/15 min. CEILING-NIOSH, INORGANIC CMPD. 5 mg As/m^3 IDLH-CARCINOGEN, INORGANIC COMPOUNDS

TWA – Time Weighted Average over 8 hours
IDLH - Immediately dangerous to life & health

See the OSHA Inorganic Arsenic Standard at 29 CFR 1910.1018 before processing.

SECTION C - PHYSICAL PROPERTIES

BOILING POINT (°C) : SUBLIMES @ 615
MELTING POINT (°C) : 817 @ 3.6477 Mpa
VAPOR PRESSURE (mm Hg) : 1mm @ 372ºC
VAPOR DENSITY (AIR=1) : N/A
SOLUBILITY IN WATER : INSOLUBLE
ODOR THRESHOLD : N/A
APPEARANCE & ODOR : SILVER GRAY CRYSTALLINE CHUNKS, RODS, OR GRANULES; NO ODOR AS METAL AS COMPOUND, AsH_3 HAS GARLIC ODOR

SPECIFIC GRAVITY : 5.72
FREEZING POINT (°) : N/A
PERCENT VOLATILE (BY WT.) : N/A
EVAPORATION RATE : N/A
pH (0 % IN WATER) : NONE

SECTION D - FIRE & EXPLOSION DATA

FLASH POINT (°) : NONE

FLAMMABLE LIMITS : **LEL** : **(N/A)** **UEL : (N/A)** **AUTO IGNITION TEMP (° F)**: **(UNKNOWN)**
EXTINGUISHING MEDIA : **WATER** : **()** **FOAM** : **(X)** **CO_2**: **(X)** **DRY CHEMICAL**: **(X)**

SPECIAL FIRE FIGHTING PROCEDURES : ARSENIC IN MASS FORM IS NON-FLAMMABLE. IN THE EVENT OF A FIRE, RESTRICT PERSONS NOT WEARING PROTECTIVE EQUIPMENT FROM AREA. TRY TO SNUFF FIRE WITH SAND, DRY MEDIA, FOAM OR CO_2. IF NO OTHER OPTIONS AVAILABLE, USE WATER & ALWAYS WEAR SELF CONTAINED BREATHING APPARATUS OR NIOSH TOXIC VAPOR RESPIRATOR. POISONOUS GASES ARE PRODUCED IN FIRE, INCLUDING ARSENIC OXIDES.

UNUSUAL FIRE & EXPLOSION HAZARDS : ARSENIC, WHEN HEATED OR IN CONTACT WITH ACID OR ACID FUMES, CAN PRODUCE HIGHLY TOXIC FUMES (SUCH AS ARSINE). ARSENIC REACTS VIGOROUSLY WITH OXIDIZING MATERIALS. ARSENIC IS FLAMMABLE IN THE FORM OF DUST WHEN EXPOSED TO HEAT OR FLAME OR BY CHEMICAL REACTION WITH POWERFUL OXIDIZERS (SEE SECTION E). SLIGHT EXPLOSION HAZARD EXISTS IN THE FORM OF DUST WHEN EXPOSED TO FLAME. IN THE EVENT OF A FIRE OR SPILL, CONTACT THE STATE DEPT. OF THE ENVIRONMENT & YOUR REGIONAL OFFICE OF THE FEDERAL ENVIRONMENTAL PROTECTION AGENCY.

SECTION E - REACTIVITY DATA

STABILITY : STABLE
INCOMPATIBILITY : HYDROGEN GAS CAN REACT WITH INORGANIC ARSENIC TO FORM THE HIGHLY TOXIC GAS ARSINE. INCOMPATIBLE WITH BROMINE AZIDE, DIRUBIDIUM ACETYLIDE, HALOGENS, PALLADIUM ZINC, PLATINUM, NCl_3, $AgNO_3$, CrO_3, Na_2O_2, HEXAFLUOROISOPROPYLIDENEAMINO LITHIUM. CAN REACT WITH ACIDS OR ACID FUMES AND POWERFUL OXIDIZERS SUCH AS BROMATES, CHLORATES, IODATES, PEROXIDES, LITHIUM, $NaCl_3$, KNO_3, $KMnO_3$, Rb_2C_2, $AgNO_4$, NOCl, IF_5, CrO_3, ClF_3, ClO, BrF_3, BrF_5, BrN_3, RbC_3BCH, CsC_3BCH.
HAZARDOUS DECOMPOSITION PRODUCTS : ARSENIC FUMES, ARSINE, OTHER ARSENIC COMPOUNDS
HAZARDOUS POLYMERIZATION : WILL NOT OCCUR
CONDITIONS TO AVOID : AVOID OPEN CONTAINERS AND CONTACT WITH INCOMPATIBLE MATERIALS

N/A = NOT APPLICABLE

SECTION F - PERSONAL PROTECTIVE EQUIPMENT INFO

RESPIRATORY EQUIPMENT : FOR HANDLING ELEMENTAL ARSENIC IN CHUNK, ROD, OR GRANULES USE NIOSH APPROVED, AIR PURIFYING, TOXIC VAPOR RESPIRATOR FOR PARTICULATE & FUME/ AIR LEVEL. IF PROCESSING MATERIAL INTO INORGANIC ARSENIC COMPOUNDS, CHOOSE PROPER RESPIRATORY PROTECTION IN ACCORDANCE WITH THE OSHA INORGANIC ARSENIC STANDARD AT 29 CFR 1910.1018 (h). FOR UNKNOWN CONCENTRATIONS OF INORGANIC ARSENIC OR UNDER FIRE-FIGHTING CONDITIONS USE FULL FACEPIECE SELF-CONTAINED BREATHING APPARATUS OPERATED IN POSITIVE PRESSURE MODE.

PROTECTIVE GLOVES : NEOPRENE OR PLASTIC

EYE PROTECTION : FACE SHIELD OR VENTED GOGGLES FOR WHEN DUST/ FUME OR INORGANIC COMPOUNDS ARE GENERATED.

VENTILATION : LOCAL EXHAUST/MECHANICAL(GENERAL) SCRUBBER OR TRAP IF POSSIBLE TO MAINTAIN EXPOSURE TO LESS THAN PERMISSIBLE LIMITS FOR ELEMENTAL ARSENIC AND ANY COMPOUNDS BEING GENERATED (SEE SECTION B)

OTHER PROTECTIVE EQUIPMENT : LAB COAT, COVERALLS, COVERLETS FOR SHOES, AND ACCESS TO EYEWASH FOUNTAIN FOR DUST OR INORGANIC COMPOUND GENERATION

SECTION G - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE : 0.01mg/m^3 TWA ARSENIC, ELEMENTAL & INORGANIC COMPOUNDS(EXCEPT ARSINE), AS As

PRIMARY ROUTES OF EXPOSURE : INHALATION OF FUMES, DUST, REACTION GASES; INGESTION; SKIN CONTACT

ORAL LD_{50} : 763 mg/m^3 RAT; ORAL RAT TDLo 605 micrograms/kg – REPRODUCTIVE EFFECTS; ORAL-MAN TDLo 7857 mg/kg/55 year old – SKIN & GASTROINTESTINAL EFFECTS

DERMAL IRRITATION-RABBIT : UNKNOWN; SUBCUTANEOUS RABBIT LDLo: 300 mg/kg

EYE IRRITATION-RABBIT : UNKNOWN

OSHA PEL : 0.01mg/m^3 TWA INORGANIC COMPOUNDS AS As; 0.5 mg/m^3 TWA ORGANIC COMPOUNDS AS As.

ACGIH TLV : 0.01mg/m^3 TWA ELEMENTAL ARSENIC & INORGANIC COMPOUNDS (EXCEPT ARSINE), AS As

EFFECTS OF OVEREXPOSURE : ARSENIC METAL IS NOT AS READILY AVAILABLE IN THE BODY AS ARSENIC IN THE FORM OF DUST OR VAPOR OR WHEN PROCESSED INTO ARSENIC COMPOUNDS (ARSENICALS). INORGANIC ARSENICALS ARE MORE TOXIC THAN ORGANIC ARSENICALS.

ACUTE EFFECTS: ARSENIC IS A POISON BY SUBCUTANEOUS, INTRAMUSCULAR, AND INTRAPERITONEAL ROUTES. ACUTE ARSENIC POISONING FROM INGESTION RESULTS IN BURNING LIPS, THROAT CONSTRICTION, ABDOMINAL PAIN, MARKED IRRITATION OF THE STOMACH AND INTESTINES WITH NAUSEA, VOMITING, AND DIARRHEA. IN SEVERE CASES THE STOOLS AND VOMIT ARE BLOODY AND THE PATIENT MAY GO INTO COLLAPSE AND SHOCK WITH WEAK, RAPID PULSE, COLD SWEATS, COMA, AND DEATH. INHALATION MAY CAUSE ULCERATION OF NASAL SEPTUM, RESPIRATORY IRRITATION (COUGH, SORE THROAT), SHORTNESS OF BREATH AND WEAKNESS. SKIN OR EYE CONTACT MAY CAUSE DERMATITIS, SKIN AND EYE IRRITATION. AFTER ABSORPTION, ARSENIC MAY CAUSE MULTI-ORGAN FAILURE AS DELAYED EFFECTS. ARSENIC IS AN EXPERIMENTAL TERATOGEN (MAY CAUSE DAMAGE TO THE DEVELOPING FETUS) AND MAY CAUSE SPONTANEOUS ABORTION OR STILLBIRTH WITH EITHER ACUTE OR CHRONIC POISONING.

CHRONIC EFFECTS: ARSENIC IS A CONFIRMED HUMAN CARCINOGEN AND HAS BEEN ASSOCIATED WITH LUNG, BLADDER, SKIN, AND OTHER CANCERS IN HUMANS. CHRONIC ARSENIC POISONING MAY INCLUDE ANY OR ALL OF THE FOLLOWING: DIGESTIVE SYSTEM DISTURBANCES, LOSS OF APPETITE, CRAMPS, NAUSEA, CONSTIPATION, DIARRHEA; LIVER DAMAGE WHICH MAY RESULT IN JAUNDICE; DISTURBANCES OF THE BLOOD, KIDNEYS AND NERVOUS SYSTEM; SKIN ABNORMALITIES INCLUDING ITCHING, PIGMENTATION, AND POSSIBLE CANCEROUS CHANGES. ARSENIC HAS INDUCED DNA DAMAGE IN HUMAN CELLS.

TARGET ORGANS (NIOSH) : (FOR INORGANIC COMPOUNDS AS As): LIVER, KIDNEYS, SKIN, LUNGS, LYMPHATIC SYSTEM

KNOWN EFFECTS ON OTHER ILLNESSES : EXPECTED TO AGGRAVATE PRE-EXISTING GASTROINTESTINAL, NERVOUS SYSTEM, SKIN, LIVER & KIDNEY PROBLEMS.

LISTED CARCINOGEN : NONE **()** OSHA **(YES)** NTP **(YES)** IARC **(YES)** OTHER **(YES)**

SECTION H – EMERGENCY & FIRST AID DATA

SKIN : FLUSH WITH SOAP & WATER. AVOID RUBBING INTO THE SKIN. CONTACT PHYSICIAN IMMEDIATELY.

EYES : FLUSH WITH WATER FOR AT LEAST 15 MINUTES, LIFTING UPPER AND LOWER EYELIDS. CONTACT PHYSICIAN IMMEDIATELY.

INHALATION : REMOVE TO FRESH AIR. PROVIDE OXYGEN IF NECESSARY. CONTACT PHYSICIAN IMMEDIATELY.

INGESTION : IMMEDIATELY CALL POISON CONTROL OR A PHYSICIAN. DO NOT INDUCE VOMITING UNLESS DIRECTED TO DO SO BY POISON CONTROL OR EMERGENCY MEDICAL PERSONNEL. TAKE TO HOSPITAL IMMEDIATELY.

MEDICAL NOTE: AGGRESSIVE DECONTAMINATION WITH GASTRIC LAVAGE IS RECOMMENDED. IF AN X-RAY INDICATES THE PRESENCE OF ARSENIC IN THE LOWER GI TRACT, WHOLE BOWEL IRRIGATION SHOULD BE CONSIDERED. ACTIVATED CHARCOAL MAY NOT BIND SIGNIFICANT AMOUNTS BUT IS RECOMMENDED UNTIL DEFINITIVE QUANTITATIVE DATA IS AVAILABLE. FLUID REPLETION SHOULD BEGIN AS SOON AS POSSIBLE.

SECTION I - SPILL & DISPOSAL INFORMATION

STEPS TO BE TAKEN IN CASE OF SPILL OR LEAK:

EVACUATE THE DANGER AREA. WEARING FULL PROTECTIVE EQUIPMENT (RESPIRATOR, GLOVES, GOGGLES, LAB COAT), GATHER UP CHUNKS, RODS, OR GRANULES WITH VACUUM OR UTENSILS RESERVED FOR POISONOUS SOLIDS AND PLACE IN SUITABLE CONTAINER AND SEAL. DO NOT RELEASE TO THE ENVIRONMENT. AVOID GENERATING DUST. VENTILATE THE AREA AFTER CLEANUP OF MATERIAL AND RESIDUE IS COMPLETE.

WASTE DISPOSAL INFORMATION:

SOLID WASTES SHOULD BE VITRIFIED, PLACED IN LABELED CONTAINER & BURIED IN AN EPA SUPERVISED FACILITY. ETCHING SOLUTIONS & CUTTING WASTES SHOULD BE PRECIPITATED, CEMENTED/VITRIFIED & PLACED IN METAL/PLASTIC LABELED CONTAINERS & BURIED IN EPA SUPERVISED FACILITY. PASS GAS THROUGH POTASSIUM PERMANGANATE, PRECIPITATE & TREAT AS ABOVE. WASTE MAY BE CONSIDERED HAZARDOUS DEPENDING ON LEVEL OF TOXICITY CHARACTERISTIC OF ARSENIC. SEE 40 CFR 261.24 FOR DETERMINATION.

RCRA HAZARDOUS WASTE : NO **()** YES **(**X)** **RCRA # : (****D004**)**

**** -** IF TESTED POSITIVE AS CHARACTERISTIC OF TOXICITY FOR ARSENIC

CERCLA : NO **()** YES **(X)** **RQ (**1 LB. RQ IS APPLICABLE ONLY IF THE DIAMETER OF THE PIECES OF THE SOLID METAL RELEASED IS LESS THAN 100 MICROMETERS OR 0.004 INCH. THIS PRODUCT FORM IS LARGER THAN 100 MICROMETERS AND HAS NO RQ IN ITS CURRENT FORM. IF AS HAZARDOUS WASTE CHARACTERISTIC OF ARSENIC, THEN RQ=1 LB.**)**

FOLLOW ALL LOCAL, STATE AND FEDERAL INFORMATION AND REGULATIONS

SECTION J - OTHER REGULATORY INFORMATION

TSCA: WE CERTIFY THAT ALL COMPONENTS OF THIS PRODUCT ARE REGISTERED UNDER THE REGULATIONS OF THE TOXIC SUBSTANCES CONTROL ACT.

SARA TITLE III, SECT. 313: **LISTED (X) UNLISTED ()**

DOT REGULATED: YES: (X**)** **NO: ()** **RQ: (**N/A - PIECES ARE LARGER THAN 100 MICROMETERS IN DIAMETER**)**

IF REGULATED, PROPER SHIPPING NAME: ARSENIC **HAZARD CLASS: (**6.1**)**

IDENTIFICATION NO.: (UN1558**)** **PACKING GROUP: (**II**)** **LABEL REQUIRED: (**POISON**)**

INLAND B/L: UN1558, ARSENIC, 6.1, PACKING GROUP II, POISON

EMERGENCY RESPONSE GUIDE NO.: (152**)**

SECTION K - SPECIAL PRECAUTIONS

FOR INDUSTRIAL USE ONLY

HANDLING & STORAGE INFORMATION:

PRIOR TO WORKING WITH ARSENIC, PERSONNEL SHOULD BE TRAINED IN PROPER HANDLING & STORAGE. STORE IN ORIGINAL PACKAGING IN COOL DRY AREA. WHEN HANDLING, WEAR FULL PROTECTIVE EQUIPMENT (SEE SECTION F). PLACE INTO INERT ATMOSPHERE IMMEDIATELY. IF PROCESSING INTO INORGANIC ARSENIC COMPOUNDS, FOLLOW THE OSHA STANDARD AT 29 CFR 1910.1018. DO NOT INGEST. DO NOT INHALE DUST OR ANY PROCESSING FUMES. AVOID SKIN AND EYE CONTACT.

NOTE: MAINTENANCE PERSONNEL OF PROCESSING AND EXTRACT EQUIPMENT MUST ALSO WEAR FULL PROTECTIVE EQUIPMENT (SEE SECTION F) AND OBSERVE THE REQUIREMENTS OF THE OSHA INORGANIC ARSENIC STANDARD (29 CFR 1910.1018) AS RESIDUES MAY CONTAIN ARSENIC PARTICLES AND VARYING COMPOUNDS OF ARSENIC.

OTHER PRECAUTIONS :

MINIMUM - HAVE QUARTERLY MEDICAL CHECKS INCLUDING URINE TESTS OF PERSONNEL WORKING WITH ARSENIC OR ARSENIC COMPOUNDS. DO NOT EAT, DRINK OR SMOKE IN THE WORK AREA.

IN ACCORDANCE WITH GOOD PRACTICES OF PERSONAL HYGIENE, HANDLE WITH DUE CARE AND AVOID ANY UNNECESSARY CONTACT WITH THIS PRODUCT.
THIS INFORMATION IS BEING SUPPLIED TO YOU UNDER OSHA "RIGHT TO KNOW" REGULATION 29 CFR 1910.1200 AND IS OFFERED IN GOOD FAITH AS TYPICAL VALUES AND NOT AS PRODUCT SPECIFICATION. THE INFORMATION IS BELIEVED TO BE TRUE AND ACCURATE. NO WARRANTY, EXPRESSED OR IMPLIED, REGARDING THE ACCURACY OF THIS DATA, THE HAZARD CONNECTED WITH USE OF THE MATERIAL, OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF, IS MADE. UNITED MINERAL AND CHEMICAL CORPORATION AND ITS SUPPLIERS ASSUME NO RESPONSIBILITY FOR DAMAGE OR INJURY FROM THE USE OF THE PRODUCT DESCRIBED HEREIN.
UNITED MINERAL & CHEMICAL CORPORATION

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Cadmium
Catalog Numbers:
S79935, C3 500, C3-500, C3500
Synonyms:
Colloidal cadmium
Company Identification: Fisher Scientific
1 Reagent Lane
Fairlawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
7440-43-9	**Cadmium**	ca.100	231-152-8

Hazard Symbols: T+ F
Risk Phrases: 11 25 26 45

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Highly flammable. Toxic if swallowed. Very toxic by inhalation. May cause cancer.Cancer suspect agent.Air sensitive.

Potential Health Effects

Eye:
Causes eye irritation.

Skin:
Causes skin irritation.

Ingestion:
Harmful if swallowed. May cause gastrointestinal irritation with nausea, vomiting and diarrhea. Ingestion may produce fluid loss, acute renal failure, and cardiopulmonary depression.

Inhalation:
May be fatal if inhaled. Inhalation of fumes may cause metal fume fever, which is characterized by flu-like symptoms with metallic taste, fever, chills, cough, weakness, chest pain, muscle pain and increased white blood cell count. Damage may be delayed. May cause nausea, vomiting, abdominal pain, diarrhea, chest tightness, weakness, and delayed pulmonary edema. In humans inhalation causes proteinuria, an excess of protein in the urine.

Chronic:
May cause respiratory tract cancer. Repeated inhalation may cause chronic bronchitis. Chronic inhalation may cause nasal septum ulceration and perforation. **Cadmium** and compounds may cause lung, liver and kidney damage and lung and prostrate cancer in humans. May cause loss of smell, emphysema, anemia, bone demineralization, and lung fibrosis.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:
Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.

Skin:
Get medical aid. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse.

Ingestion:
Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.

Inhalation:
Get medical aid immediately. Remove from exposure to fresh air immediately. If breathing is difficult, give oxygen. Do NOT use

mouth-to-mouth resuscitation. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.

Notes to Physician:

Blood **cadmium** levels are not indicative of exposure. Administration of Calcium Disodium EDTA may be useful in acute poisoning with its use at the discretion of qualified medical personnel. Persons with kidney disease, chronic respiratory disease, liver disease, or skin disease may be at increased risk from exposure to this substance.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:

As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Dust can be an explosion hazard when exposed to heat or flame. Flammable solid. May burn rapidly with flare burning effect. May re-ignite after fire is extinguished. Dangerous fire hazard in the form of dust when exposed to heat or flame.

Extinguishing Media:

Do NOT use water directly on fire. Use dry chemical to fight fire. Cool containers with flooding quantities of water until well after fire is out.

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Vacuum or sweep up material and place into a suitable disposal container. Avoid generating dusty conditions. Remove all sources of ignition. Use a spark-proof tool. Provide ventilation. Place under an inert atmosphere.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:
Wash thoroughly after handling. Wash hands before eating. Remove contaminated clothing and wash before reuse. Minimize dust generation and accumulation. Use spark-proof tools and explosion proof equipment. Avoid contact with skin and eyes. Do not breathe dust, vapor, mist, or gas. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Avoid contact with heat, sparks and flame. Do not ingest or inhale. Handle under an inert atmosphere. Store protected from air. Use only in a chemical fume hood. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames.

Storage:
Keep away from heat and flame. Keep away from sources of ignition. Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Do not expose to air. Store under an inert atmosphere.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:
Use explosion-proof ventilation equipment. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use only under a chemical fume hood.

Personal Protective Equipment

Eyes:
Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin:
Wear appropriate protective gloves to prevent

skin
exposure.
Clothing:
Wear appropriate protective clothing to prevent
skin
exposure.
Respirators:
A respiratory protection program that meets
OSHA's 29
CFR :1910.134 and ANSI Z88.2 requirements or
European
Standard EN 149 must be followed whenever
workplace
conditions warrant a respirator's use.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Powder
Appearance:	silver white
Odor:	odorless
pH:	Not available.
Vapor Pressure:	1 mm Hg @ 394 deg C
Vapor Density:	Not available.
Evaporation Rate:	Not applicable.
Viscosity:	Not applicable.
Boiling Point:	765 deg C
Freezing/Melting Point:	321 deg C
Autoignition Temperature:	Not available.
Flash Point:	Not available.
Explosion Limits, lower:	Not available.
Explosion Limits, upper:	Not available.
Decomposition Temperature:	Not available.
Solubility:	Insoluble.
Specific Gravity/Density:	8.65 @ 25&C
Molecular Formula:	Cd
Molecular Weight:	112.41

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Oxidizes when exposed to air. Easily tarnishes in moist air.
Powder
or liquid is pyrophoric.
Conditions to Avoid:
Incompatible materials, ignition sources, dust generation,
exposure
to air, excess heat.
Incompatibilities with Other Materials:
Air, nitric acid, hydrochloric acid, hydrazoic acid, nitryl

fluoride,
ammonium nitrate, zinc, oxidizing agents, acids, hydrogen azide,
potassium, sulfur, selenium, tellurium, metals, carbonates, cyanides
(e.g. potassium cyanide, sodium cyanide), hydroxides, reducing agents
(strong, e.g. aluminum carbide, chlorosilane, hydrogen phosphide,
lithium hydride).

Hazardous Decomposition Products:
Nitrogen oxides, toxic **cadmium** oxide fumes.

Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 7440-43-9: EU9800000

LD50/LC50:
CAS# 7440-43-9: Inhalation, rat: LC50 = 25 mg/m3/30M; Oral, mouse:
LD50 = 890 mg/kg; Oral, rat: LD50 = 2330 mg/kg.

Carcinogenicity:
Cadmium -
ACGIH: A2 - suspected human carcinogen (elemental)
California: carcinogen; initial date 10/1/87
NIOSH: occupational carcinogen
NTP: Known carcinogen
OSHA: Select carcinogen
IARC: Group 1 carcinogen

Epidemiology:
Occupational exposure to **cadmium** has been implicated in a significant
increase in prostate and respiratory tract cancer. There is evidence
of a significant excess of respiratory cancer deaths among a cohort
of **cadmium** production workers, and concluded that **cadmium** and its
compounds are potential carcinogens.

Teratogenicity:
Oral, rat: TDLo = 155 mg/kg (male 13 week(s) pre-mating and female 13
week(s) pre-mating - 3 week(s) after conception) Effects on Newborn -
growth statistics (e.g.%, reduced weight gain) and Effects on Newborn
- behavioral.; Oral, rat: TDLo = 23 mg/kg (female 1-22 day (s) after

conception) Specific Developmental Abnormalities - blood and lymphatic systems (including spleen and marrow).; Oral, mouse: TDLo = 1700 mg/kg (female 8-12 day(s) after conception) Effects on Newborn - viability index (e.g., # alive at day 4 per # born alive) and Effects on Newborn - growth statis

Reproductive Effects:

Oral, rat: TDLo = 21500 ug/kg (multigenerations) Fertility - pre-implantation mortality (e.g. reduction in number of implants per female; total number of implants per corpora lutea).; Intraperitoneal, rat: TDLo = 1124 ug/kg (male 1 day(s) pre-mating) Paternal Effects - spermatogenesis (incl. genetic material, sperm morphology, motility, and count).

Neurotoxicity:

No information available.

Mutagenicity:

Micronucleus Test: Mouse, Embryo = 6 umol/L.; Cytogenetic Analysis: Hamster, Ovary = 1 umol/L.

Other Studies:

The long-term ingestion of water, beans and rice contaminated with **cadmium** has been proposed as the probable cause of crippling condition (itai-itai disease) among Japanese women who have had multiple pregnancies. Characteristics of the disorder are: pain in the back and joints, a waddly gait, osteomalacia, bone fractures, and occasional fatal renal failure.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:

Fish: Rainbow trout: TLm = 30 ppm; 24 Hr; Hard waterFish: Striped bass: LC50 = 0.001 ppm; 24-48 Hr; Static bioassayFish: Fathead Minnow: TL50 = 7.2 ppm; 96 Hr; UnspecifiedFish: Bluegill/Sunfish: LCO = 0.08 ppm; 96 Hr; Static bioassay (Hard water)

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
Shipping Name: FLAMMABLE SOLID, INORGANIC, N.O.S. (**CADMIUM**)
Hazard Class: 4.1
UN Number: UN3178
Packing Group: III
Canadian TDG
Shipping Name: FLAMMABLE SOLID NOS (**CADMIUM** METAL)
Hazard Class: 4.1
UN Number: UN1325

**** SECTION 15 - REGULATORY INFORMATION ****

US FEDERAL
TSCA
CAS# 7440-43-9 is listed on the TSCA inventory.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous
Substances under the CWA.
CAS# 7440-43-9 is listed as a Priority Pollutant under the Clean
Water Act.
CAS# 7440-43-9 is listed as a Toxic Pollutant under the Clean Water
Act.
OSHA:
None of the chemicals in this product are considered highly hazardous
by OSHA.
STATE
Cadmium can be found on the following state right to know lists: California, New Jersey, Florida, Pennsylvania, Minnesota, Massachusetts.
The following statement(s) is(are) made in order to comply with the California Safe Drinking Water Act:
WARNING: This product contains **Cadmium**, a chemical known to the state of California to cause cancer.
WARNING: This product contains **Cadmium**, a chemical known to the state of California to cause birth defects or other reproductive harm.
California No Significant Risk Level:

CAS# 7440-43-9: inhalation: no significant risk level = 0.05 ug/day

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols: T+ F

Risk Phrases:

R 11 Highly flammable.
R 25 Toxic if swallowed.
R 26 Very toxic by inhalation.
R 45 May cause cancer.

Safety Phrases:

S 53 Avoid exposure - obtain special instructions before use.
S 36/37/39 Wear suitable protective clothing, gloves and eye/face protection.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

WGK (Water Danger/Protection)

CAS# 7440-43-9: No information available.

United Kingdom Occupational Exposure Limits

Canada

CAS# 7440-43-9 is listed on Canada's DSL List.
CAS# 7440-43-9 is listed on Canada's Ingredient Disclosure List.

Exposure Limits

CAS# 7440-43-9: OEL-ARAB Republic of Egypt:TWA 0.05 mg/m3
OEL-AUSTRALIA:TWA 0.05 mg/m3
OEL-BELGIUM:TWA 0.05 mg/m3
OEL-CZECHOSLOVAKIA:TWA 0.05 mg/m3;STEL 0.1 mg/m3
OEL-DENMARK:TWA 0.01 mg/m3
OEL-FINLAND:TWA 0.02 mg/m3;Carcinogen
OEL-GERMANY;Carcinogen
OEL-INDIA:TWA 0.05 mg/m3
OEL-JAPAN:TWA 0.05 mg/m3
OEL-THE NETHERLANDS:TWA 0.02 mg/m3;STEL 0.1 mg/m3
OEL-THE PHILIPPINES:TWA 0.2 mg/m3
OEL-RUSSIA:TWA 0.01 mg/m3;STEL 0.05 mg/m3
OEL-SWEDEN:TWA 0.02 mg/m3;Carcinogen
OEL-SWITZERLAND:TWA 0.05 mg/m3
OEL-THAILAND:TWA 0.2 mg/m3;STEL 0.5 mg/m3
OEL-TURKEY:TWA 0.2 mg/m3
OEL-UNITED KINGDOM:TWA 0.01 mg/m3
OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV
OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 6/28/1999 Revision #2 Date: 8/02/2000

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall the company be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if the company has been advised of the possibility of such damages.

Back to MSDS page

Material Safety Data Sheet

Science Stuff, Inc.
1104 Newport Ave
Austin, TX 78753

Phone (512) 837-6020
Chemtrec 800-424-9300
24 Hour Emergency Assistance

Section 1 Identification

Product Number:	C1504
Product Name:	Chromium Metal Powder, 100 Mesh, 99.5%
Trade/Chemical Synonyms	
Formula:	Cr
RTECS:	GB4200000
C.A.S	CAS# 7440-47-3

Health:	2
Flammability	2
Reactivity	0

Hazard Rating:
Least Slight Moderate High Extreme
0 1 2 3 4
NA = Not Applicable NE = Not Established

Section 2 Component Mixture

Sara 313	Component	CAS Number	%	Dim	Exposure Limits:
☑	Chromium Metal Powder, 100 Mesh, 99.5%	CAS# 7440-47-3	100%	W/W	OSHA TWA 1 mg/m*f*

Section 3 Hazard Identification (Also see section 11)

Keep away from heat and ignition sources. Harmful if swallowed. Avoid breathing vapors. Use with adequate ventilation. Avoid contact with eyes, skin, and clothes. Wash thoroughly after handling. Keep container closed.

Section 4 First Aid Measures

Keep away from heat and ignition sources. Harmful if swallowed. Avoid breathing vapors. Use with adequate ventilation. Avoid contact with eyes, skin, and clothes. Wash thoroughly after handling. Keep container closed.

FIRST AID: SKIN: Remove contaminated clothing. Wash exposed area with soap and water. If symptoms persist, seek medical attention

EYES: Wash eyes with plenty of water for at least 15 minutes, lifting lids occasionally. Seek Medical Aid. INHALATION: Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen

INGESTION: If swallowed, induce vomiting immediately after giving two glasses of water. Never give anything by mouth to an unconscious person.

Section 5 Fire Fighting Measures

Fire Extinguisher Type:	Carbon Dioxide, dry chemical or sand. Do not disturb burning metal while extinguishing the fire.
Fire/Explosion Hazards:	Dust at sufficient concentrations can form explosive mixtures with air.
Fire Fighting Procedure:	Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and clothing.

Section 6 Accidental Release Measures

Sweep up and place in suitable (fiberboard) containers for reclamation or later disposal.

Section 7 Handling and Storage

Precautions such as the use of inert atmosphere are advisable when sizing material to minus 100 mesh and when 50% is minus 200 mesh

Section 8 Exposure Controls & Personal Protection

Respiratory Protection:NIOSH/MSHA-approved respirator

Ventilation: Mechanical: ☐ Local Exhaust: ☑

Hand Protection: NIOSH Approved Gloves

Eye Protection: Splash Goggles

Other Protective Equipment: Wear appropriate clothing to prevent skin exposure

Section 9 Physical and Chemical Properties

Melting Point:	3326 Deg. F	Specific Gravity	7.14
Boiling Point:	3992 Deg. F	Percent Volatile by Volume:	N/A
Vapor Pressure:	N/A	Evaporation Rate:	N/A
Vapor Density:	N/A	Evaporation Standard:	
Solubility in Water:	Not soluble	Auto ignition Temperature:	Not applicable
Appearance and Odor:		Lower Flamm. Limit in Air:	Not applicable
Flash Point:	N/A	Upper Flamm. Limit in Air:	Not applicable

Section 10 Stability and Reactivity Information

Stability: Stable

Conditions to Avoid: Avoid contact with incompatible materials.

Materials to Avoid:
Acidic conditions

Hazardous Decomposition Products:
Not known to occur

Hazardous Polymerization:Will Not Occur

Condition to Avoid:None known

Section 11 Additional Information

Overexposure to dust may irritate eyes, nose or throat. Conditions aggravated/target organs. Persons with pre-existing eye, skin or respiratory conditions may be more susceptible.

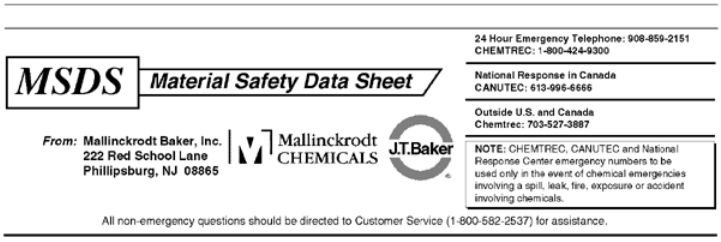
DOT Classification: Metal Powder, Flammable, n.o.s. (Chromium Metal Powder), 4.1, UN3089, PG III

DOT regulations may change from time to time. Please consult the most recent version of the relevant regulations.

Revision No:0	Date Entered: 9/1/2006	Approved by: WPF

The information contained herein is believed to be accurate and is offered in good faith for the user's consideration and investigation. No warranty is expressed or implied regarding the completeness or accuracy of this information, whether originating from Science Stuff, Inc. or from an alternate source. Users of this material should satisfy themselves by independent investigation of current scientific and medical information that this material may be safely handled.

MSDS Number: **L2347** * * * * * *Effective Date:* ***09/15/09*** * * * * * *Supercedes:* ***07/05/07***



LEAD METAL

1. Product Identification

Synonyms: Granular lead, pigment metal; C.I. 77575
CAS No.: 7439-92-1
Molecular Weight: 207.19
Chemical Formula: Pb
Product Codes:
J.T. Baker: 2256, 2266
Mallinckrodt: 5668

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Lead	7439-92-1	95 - 100%	Yes

3. Hazards Identification

Emergency Overview

POISON! DANGER! MAY BE FATAL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. NEUROTOXIN. AFFECTS THE GUM TISSUE, CENTRAL NERVOUS SYSTEM, KIDNEYS, BLOOD AND REPRODUCTIVE SYSTEM. POSSIBLE CANCER HAZARD. MAY CAUSE CANCER BASED ON ANIMAL DATA. Risk of cancer depends on duration and level of exposure.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Cancer Causing)
Flammability Rating: 3 - Severe (Flammable)
Reactivity Rating: 1 - Slight
Contact Rating: 2 - Moderate (Life)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: Red (Flammable)

Potential Health Effects

Inhalation:

Lead can be absorbed through the respiratory system. Local irritation of bronchia and lungs can occur and, in cases of acute exposure, symptoms such as metallic taste, chest and abdominal pain, and increased lead blood levels may follow. See also Ingestion.
Ingestion:
POISON! The symptoms of lead poisoning include abdominal pain and spasms, nausea, vomiting, headache. Acute poisoning can lead to muscle weakness, "lead line" on the gums, metallic taste, definite loss of appetite, insomnia, dizziness, high lead levels in blood and urine

with shock, coma and death in extreme cases.
Skin Contact:
Lead and lead compounds may be absorbed through the skin on prolonged exposure; the symptoms of lead poisoning described for ingestion exposure may occur. Contact over short periods may cause local irritation, redness and pain.
Eye Contact:
Absorption can occur through eye tissues but the more common hazards are local irritation or abrasion.
Chronic Exposure:
Lead is a cumulative poison and exposure even to small amounts can raise the body's content to toxic levels. The symptoms of chronic exposure are like those of ingestion poisoning; restlessness, irritability, visual disturbances, hypertension and gray facial color may also be noted.
Aggravation of Pre-existing Conditions:
Persons with pre-existing kidney, nerve or circulatory disorders or with skin or eye problems may be more susceptible to the effects of this substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Immediately flush skin with plenty of soap and water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard. Powder/dust is flammable when heated or exposed to flame.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire. Do not allow water runoff to enter sewers or waterways.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Can produce toxic lead fumes at elevated temperatures and also react with oxidizing materials.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Areas in which exposure to lead metal or lead compounds may occur should be identified by signs or appropriate means, and access to the area should be limited to authorized persons. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For lead, metal and inorganic dusts and fumes, as Pb:
-OSHA Permissible Exposure Limit (PEL): 0.05 mg/m3 (TWA)
For lead, elemental and inorganic compounds, as Pb:
-ACGIH Threshold Limit Value (TLV): 0.05 mg/m3 (TWA), A3 animal carcinogen

ACGIH Biological Exposure Indices (BEI): 30 ug/100ml, notation B (see actual Indices for more information).
For lead, inorganic:
-NIOSH Recommended Exposure Limit (REL): 0.1 mg/m3 (TWA)
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half-face high efficiency particulate respirator (NIOSH type N100 filter) may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece high efficiency particulate respirator (NIOSH type N100 filter) may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator.
WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.
Other Control Measures:
Eating, drinking, and smoking should not be permitted in areas where solids or liquids containing lead compounds are handled, processed, or stored. See OSHA substance-specific standard for more information on personal protective equipment, engineering and work practice controls, medical surveillance, record keeping, and reporting requirements. (29 CFR 1910.1025).

9. Physical and Chemical Properties

Appearance:
Small, white to blue-gray metallic shot or granules.
Odor:
Odorless.
Solubility:
Insoluble in water.
Density:
11.34
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
1740C (3164F)
Melting Point:
327.5C (622F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
1.77 @ 1000C (1832F)
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Does not decompose but toxic lead or lead oxide fumes may form at elevated temperatures.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Ammonium nitrate, chlorine trifluoride, hydrogen peroxide, sodium azide, zirconium, disodium acetylide, sodium acetylide and oxidants.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Toxicological Data:

Investigated as a tumorigen, mutagen, reproductive effector.
Reproductive Toxicity:
Lead and other smelter emissions are human reproductive hazards. (Chemical Council on Environmental Quality; Chemical Hazards to Human Reproduction, 1981).
Carcinogenicity:
EPA / IRIS classification: Group B2 - Probable human carcinogen, sufficient animal evidence.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Lead (7439-92-1)	No	No	2B

12. Ecological Information

Environmental Fate:
When released into the soil, this material is not expected to leach into groundwater. This material may bioaccumulate to some extent.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia
Lead (7439-92-1)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\----------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Lead (7439-92-1)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Lead (7439-92-1)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\----------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Lead (7439-92-1)	10	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: No (Pure / Solid)

WARNING:
THIS PRODUCT CONTAINS CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER AND BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

Australian Hazchem Code: None allocated.
Poison Schedule: S6
WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **3** Flammability: **1** Reactivity: **0**
Label Hazard Warning:
POISON! DANGER! MAY BE FATAL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. NEUROTOXIN. AFFECTS THE GUM TISSUE, CENTRAL NERVOUS SYSTEM, KIDNEYS, BLOOD AND REPRODUCTIVE SYSTEM. POSSIBLE CANCER HAZARD. MAY CAUSE CANCER BASED ON ANIMAL DATA. Risk of cancer depends on duration and level of exposure.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe dust.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:
****
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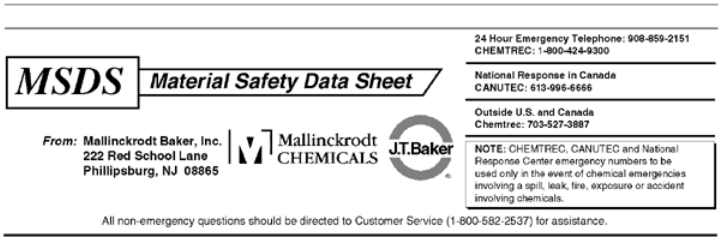
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **M1599** * * * * * *Effective Date:* ***08/20/08*** * * * * * *Supercedes:* ***12/19/05***



MERCURY

1. Product Identification

Synonyms: Quicksilver; hydrargyrum; Liquid Silver
CAS No.: 7439-97-6
Molecular Weight: 200.59
Chemical Formula: Hg
Product Codes:
J.T. Baker: 2564, 2567, 2569
Mallinckrodt: 1278, 1280, 1288

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Mercury	7439-97-6	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

DANGER! CORROSIVE. CAUSES BURNS TO SKIN, EYES, AND RESPIRATORY TRACT. MAY BE FATAL IF SWALLOWED OR INHALED. HARMFUL IF ABSORBED THROUGH SKIN. AFFECTS THE KIDNEYS AND CENTRAL NERVOUS SYSTEM. MAY CAUSE ALLERGIC SKIN REACTION.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 4 - Extreme (Life)
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 3 - Severe (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Inhalation:
Mercury vapor is highly toxic via this route. Causes severe respiratory tract damage. Symptoms include sore throat, coughing, pain, tightness in chest, breathing difficulties, shortness of breath, headache, muscle weakness, anorexia, gastrointestinal disturbance, ringing in the ear, liver changes, fever, bronchitis and pneumonitis. Can be absorbed through inhalation with symptoms similar to ingestion.
Ingestion:
May cause burning of the mouth and pharynx, abdominal pain, vomiting, corrosive ulceration, bloody diarrhea. May be followed by a rapid and weak pulse, shallow breathing, paleness, exhaustion, tremors and collapse. Delayed death may occur from renal failure. Gastrointenstinal uptake of mercury is less than 5% but its ability to penetrate tissues presents some hazard. Initial symptoms may be thirst, possible abdominal discomfort.

Skin Contact:
Causes irritaton and burns to skin. Symptoms include redness and pain. May cause skin allergy and sensitization. Can be absorbed through the skin with symptoms to parallel ingestion.
Eye Contact:
Causes irritation and burns to eyes. Symptoms include redness, pain, blurred vision; may cause serious and permanent eye damage.
Chronic Exposure:
Chronic exposure through any route can produce central nervous system damage. May cause muscle tremors, personality and behavior changes, memory loss, metallic taste, loosening of the teeth, digestive disorders, skin rashes, brain damage and kidney damage. Can cause skin allergies and accumulate in the body. Repeated skin contact can cause the skin to turn gray in color. A suspected reproductive hazard; may damage the developing fetus and decrease fertility in males and females.
Aggravation of Pre-existing Conditions:
Persons with nervous disorders, or impaired kidney or respiratory function, or a history of allergies or a known sensitization to mercury may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire. Do not allow water runoff to enter sewers or waterways.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Undergoes hazardous reactions in the presence of heat and sparks or ignition. Smoke may contain toxic mercury or mercuric oxide. Smoke may contain toxic mercury or mercuric oxide.

6. Accidental Release Measures

Ventilate area of leak or spill. Clean-up personnel require protective clothing and respiratory protection from vapor.

Spills: Pick up and place in a suitable container for reclamation or disposal in a method that does not generate misting. Sprinkle area with sulfur or calcium polysulfide to suppress mercury. Do not flush to sewer. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker CINNASORB® and RESISORB® are recommended for spills of this product.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from any source of heat or ignition. Do not use or store on porous work surfaces (wood, unsealed concrete, etc.). Follow strict hygiene practices. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

- OSHA Acceptable Ceiling Concentration:
mercury and mercury compounds: 0.1 mg/m3 (TWA), skin
- ACGIH Threshold Limit Value (TLV):
inorganic and metallic mercury, as Hg: 0.025 mg/m3 (TWA) skin, A4 Not classifiable as a human carcinogen.
- ACGIH Biological Exposure Indices:
total inorganic mercury in urine (preshift): 35 ug/g creatinine;
total inorganic mercury in blood (end of shift): 15 ug/l.

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, a half-face respirator with a mercury vapor or chlorine gas cartridge may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece respirator with a mercury vapor or chlorine gas cartridge may be worn up to 50 times the exposure limit, or the maximum use concentraiton specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-face piece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Silver-white, heavy, mobile, liquid metal.

Odor:
Odorless.

Solubility:
Insoluble in water.

Density:
13.55

pH:
No information found.

% Volatiles by volume @ 21C (70F):
100

Boiling Point:
356.7C (675F)

Melting Point:
-38.87C (-38F)

Vapor Density (Air=1):
7.0

Vapor Pressure (mm Hg):
0.0018 @ 25C (77F)

Evaporation Rate (BuAc=1):
4

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:
At high temperatures, vaporizes to form extremely toxic fumes.

Hazardous Polymerization:
Will not occur.

Incompatibilities:
Acetylenes, ammonia, ethylene oxide, chlorine dioxide, azides, metal oxides, methyl silane, lithium, rubidium, oxygen, strong oxidants, metal carbonyls.

Conditions to Avoid:
Heat, flames, ignition sources, metal surfaces and incompatibles.

11. Toxicological Information

Toxicological Data:

Investigated as a tumorigen, mutagen, reproductive effector.
Reproductive Toxicity:
All forms of mercury can cross the placenta to the fetus, but most of what is known has been learned from experimental animals. See Chronic Health Hazards.
Carcinogenicity:
EPA / IRIS classification: Group D1 - Not classifiable as a human carcinogen.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Mercury (7439-97-6)	No	No	3

12. Ecological Information

Environmental Fate:
This material has an experimentally-determined bioconcentration factor (BCF) of greater than 100. This material is expected to significantly bioaccumulate.
Environmental Toxicity:
This material is expected to be toxic to aquatic life. The LC50/96-hour values for fish are less than 1 mg/l.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: RQ, MERCURY
Hazard Class: 8
UN/NA: UN2809
Packing Group: III
Information reported for product/size: 1LB

International (Water, I.M.O.)

Proper Shipping Name: MERCURY
Hazard Class: 8
UN/NA: UN2809
Packing Group: III
Information reported for product/size: 1LB

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia
Mercury (7439-97-6)	Yes	Yes	No	Yes

--------\Chemical Inventory Status - Part 2\----------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Mercury (7439-97-6)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Mercury (7439-97-6)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\----------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Mercury (7439-97-6)	1	U151	No

```
Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No          (Pure / Liquid)
```

WARNING:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

Australian Hazchem Code: 2Z
Poison Schedule: S7
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
DANGER! CORROSIVE. CAUSES BURNS TO SKIN, EYES, AND RESPIRATORY TRACT. MAY BE FATAL IF SWALLOWED OR INHALED. HARMFUL IF ABSORBED THROUGH SKIN. AFFECTS THE KIDNEYS AND CENTRAL NERVOUS SYSTEM. MAY CAUSE ALLERGIC SKIN REACTION.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe vapor.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. In all cases get medical attention immediately.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:
****
Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.
****
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

ALCONOX MSDS

Section 1 : MANUFACTURER INFORMATION

Product name: Alconox

Supplier: Same as manufacturer.

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Manufacturer emergency phone number: 800-255-3924.
813-248-0585 (outside of the United States).

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Supplier MSDS date: 2005/03/09

D.O.T. Classification: Not regulated.

Section 2 : HAZARDOUS INGREDIENTS

C.A.S.	CONCENTRATION %	Ingredient Name	T.L.V.	LD/50	LC/50
25155-30-0	10-30	SODIUM DODECYLBENZENESULFONATE	NOT AVAILABLE	438 MG/KG RAT ORAL 1330 MG/KG MOUSE ORAL	NOT AVAILABLE
497-19-8	7-13	SODIUM CARBONATE	NOT AVAILABLE	4090 MG/KG RAT ORAL 6600 MG/KG MOUSE ORAL	2300 MG/M3/2H RAT INHALATION 1200 MG/M3/2H MOUSE INHALATION
7722-88-5	10-30	TETRASODIUM PYROPHOSPHATE	5 MG/M3	4000 MG/KG RAT ORAL 2980 MG/KG MOUSE ORAL	NOT AVAILABLE
7758-29-4	10-30	SODIUM PHOSPHATE	NOT AVAILABLE	3120 MG/KG RAT ORAL 3100 MG/KG MOUSE ORAL >4640 MG/KG RABBIT DERMAL	NOT AVAILABLE

Section 2A : ADDITIONAL INGREDIENT INFORMATION

Note: (supplier).
CAS# 497-19-8: LD50 4020 mg/kg - rat oral.
CAS# 7758-29-4: LD50 3100 mg/kg - rat oral.

Section 3 : PHYSICAL / CHEMICAL CHARACTERISTICS

Physical state: Solid

Appearance & odor: Almost odourless.
White granular powder.

Odor threshold (ppm): Not available.

Vapour pressure (mmHg): Not applicable.

Vapour density (air=1): Not applicable.

By weight: Not available.

Evaporation rate (butyl acetate = 1): Not applicable.

Boiling point (°C): Not applicable.

Freezing point (°C): Not applicable.

pH: (1% aqueous solution).
9.5

Specific gravity @ 20 °C: (water = 1).
0.85 - 1.10

Solubility in water (%): 100 - > 10% w/w

Coefficient of water\oil dist.: Not available.

VOC: None

Section 4 : FIRE AND EXPLOSION HAZARD DATA

Flammability: Not flammable.

Conditions of flammability: Surrounding fire.

Extinguishing media: Carbon dioxide, dry chemical, foam.
Water
Water fog.

Special procedures: Self-contained breathing apparatus required.
Firefighters should wear the usual protective gear.

Auto-ignition temperature: Not available.

Flash point (°C), method: None

Lower flammability limit (% vol): Not applicable.

Upper flammability limit (% vol): Not applicable.

Not available.

Sensitivity to mechanical impact: Not applicable.

Hazardous combustion products: Oxides of carbon (COx).
Hydrocarbons.

Rate of burning: Not available.

Explosive power: None

Section 5 : REACTIVITY DATA

Chemical stability: Stable under normal conditions.

Conditions of instability: None known.

Hazardous polymerization: Will not occur.

Incompatible substances: Strong acids.
Strong oxidizers.

Hazardous decomposition products: See hazardous combustion products.

Section 6 : HEALTH HAZARD DATA

Route of entry: Skin contact, eye contact, inhalation and ingestion.

Effects of Acute Exposure

Eye contact: May cause irritation.

Skin contact: Prolonged contact may cause irritation.

Inhalation: Airborne particles may cause irritation.

Ingestion: May cause vomiting and diarrhea.
May cause abdominal pain.
May cause gastric distress.

Effects of chronic exposure: Contains an ingredient which may be corrosive.

LD50 of product, species & route: > 5000 mg/kg rat oral.

LC50 of product, species & route: Not available for mixture, see the ingredients section.

Exposure limit of material: Not available for mixture, see the ingredients section.

Sensitization to product: Not available.

Carcinogenic effects: Not listed as a carcinogen.

Reproductive effects: Not available.

Teratogenicity: Not available.

Mutagenicity: Not available.

Synergistic materials: Not available.

Medical conditions aggravated by exposure: Not available.

First Aid

Skin contact: Remove contaminated clothing.
Wash thoroughly with soap and water.
Seek medical attention if irritation persists.

Eye contact: Check for and remove contact lenses.
Flush eyes with clear, running water for 15 minutes while holding eyelids open: if irritation persists, consult a physician.

Inhalation: Remove victim to fresh air.
Seek medical attention if symptoms persist.

Ingestion: Dilute with two glasses of water.
Never give anything by mouth to an unconscious person.
Do not induce vomiting, seek immediate medical attention.

Section 7 : PRECAUTIONS FOR SAFE HANDLING AND USE

Leak / Spill: Contain the spill.
Recover uncontaminated material for re-use.
Wear appropriate protective equipment.
Contaminated material should be swept or shoveled into appropriate waste container for disposal.

Waste disposal: In accordance with municipal, provincial and federal regulations.

Handling procedures and equipment: Protect against physical damage.
Avoid breathing dust.
Wash thoroughly after handling.
Keep out of reach of children.
Avoid contact with skin, eyes and clothing.
Launder contaminated clothing prior to reuse.

Storage requirements: Keep containers closed when not in use.
Store away from strong acids or oxidizers.
Store in a cool, dry and well ventilated area.

Section 8 : CONTROL MEASURES

Precautionary Measures

Gloves / Type:

Neoprene or rubber gloves.

Respiratory / Type:

If exposure limit is exceeded, wear a NIOSH approved respirator.

Eye / Type:

Safety glasses with side-shields.

Footwear / Type: Safety shoes per local regulations.

Clothing / Type: As required to prevent skin contact.

Other / Type: Eye wash facility should be in close proximity.
Emergency shower should be in close proximity.

Ventilation requirements: Local exhaust at points of emission.

MSDS Number: **H3880** * * * * * *Effective Date:* ***11/21/08*** * * * * * *Supercedes:* ***01/19/06***

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

HYDROCHLORIC ACID, 33 - 40%

1. Product Identification

Synonyms: Muriatic acid; hydrogen chloride, aqueous
CAS No.: 7647-01-0
Molecular Weight: 36.46
Chemical Formula: HCl
Product Codes:
J.T. Baker: 5367, 5537, 5575, 5800, 5814, 5821, 5839, 5861, 5862, 5894, 5962, 5963, 5972, 5994, 6900, 7831, 9529, 9530, 9534, 9535, 9536, 9538, 9539, 9540, 9544, 9548, 9551
Mallinckrodt: 2062, 2515, 2612, 2624, 2626, 3861, 5583, 5587, H611, H613, H616, H987, H992, H999, V078, V628

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Hydrogen Chloride	7647-01-0	33 - 40%	Yes
Water	7732-18-5	60 - 67%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG DAMAGE.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Inhalation:
Corrosive! Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death.
Ingestion:
Corrosive! Swallowing hydrochloric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract. May cause nausea, vomiting, and diarrhea. Swallowing may be fatal.
Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and discolor skin.

Eye Contact:
Corrosive! Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Chronic Exposure:
Long-term exposure to concentrated vapors may cause erosion of teeth. Long term exposures seldom occur due to the corrosive properties of the acid.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye disease may be more susceptible to the effects of this substance.

4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Extreme heat or contact with metals can release flammable hydrogen gas.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
If involved in a fire, use water spray. Neutralize with soda ash or slaked lime.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Structural firefighter's protective clothing is ineffective for fires involving hydrochloric acid. Stay away from ends of tanks. Cool tanks with water spray until well after fire is out.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. When opening metal containers, use non-sparking tools because of the possibility of hydrogen gas being present. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For Hydrochloric acid:
- OSHA Permissible Exposure Limit (PEL):
5 ppm (Ceiling)
- ACGIH Threshold Limit Value (TLV):
2 ppm (Ceiling), A4 Not classifiable as a human carcinogen

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a full facepiece respirator with an acid gas cartridge may be worn up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Colorless, fuming liquid.
Odor:
Pungent odor of hydrogen chloride.
Solubility:
Infinite in water with slight evolution of heat.
Density:
1.18
pH:
For HCL solutions: 0.1 (1.0 N), 1.1 (0.1 N), 2.02 (0.01 N)
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
53C (127F) Azeotrope (20.2%) boils at 109C (228F)
Melting Point:
-74C (-101F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
190 @ 25C (77F)
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Containers may burst when heated.
Hazardous Decomposition Products:
When heated to decomposition, emits toxic hydrogen chloride fumes and will react with water or steam to produce heat and toxic and corrosive fumes. Thermal oxidative decomposition produces toxic chlorine fumes and explosive hydrogen gas.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
A strong mineral acid, concentrated hydrochloric acid is incompatible with many substances and highly reactive with strong bases, metals, metal oxides, hydroxides, amines, carbonates and other alkaline materials. Incompatible with materials such as cyanides, sulfides, sulfites, and formaldehyde.
Conditions to Avoid:
Heat, direct sunlight.

11. Toxicological Information

Inhalation rat LC50: 3124 ppm/1H; oral rabbit LD50: 900 mg/kg (Hydrochloric acid concentrated); investigated as a tumorigen, mutagen, reproductive effector.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category

Hydrogen Chloride (7647-01-0)	No	No	3
Water (7732-18-5)	No	No	None

12. Ecological Information

Environmental Fate:
When released into the soil, this material is not expected to biodegrade. When released into the soil, this material may leach into groundwater.
Environmental Toxicity:
This material is expected to be toxic to aquatic life.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: HYDROCHLORIC ACID
Hazard Class: 8
UN/NA: UN1789
Packing Group: II
Information reported for product/size: 475LB

International (Water, I.M.O.)

Proper Shipping Name: HYDROCHLORIC ACID
Hazard Class: 8
UN/NA: UN1789
Packing Group: II
Information reported for product/size: 475LB

15. Regulatory Information

Risk and Safety Phrases:
Symbol: C
Risk: 34-37
Safety: (1/2-)26-45

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Hydrogen Chloride (7647-01-0)	Yes	Yes	Yes	Yes
Water (7732-18-5)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.
Hydrogen Chloride (7647-01-0)	Yes	Yes	No	Yes
Water (7732-18-5)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

	-SARA 302-		------SARA 313------	
Ingredient	RQ	TPQ	List	Chemical Catg.
Hydrogen Chloride (7647-01-0)	5000	500*	Yes	No
Water (7732-18-5)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

		-RCRA-	-TSCA-
Ingredient	CERCLA	261.33	8(d)
Hydrogen Chloride (7647-01-0)	5000	No	No
Water (7732-18-5)	No	No	No

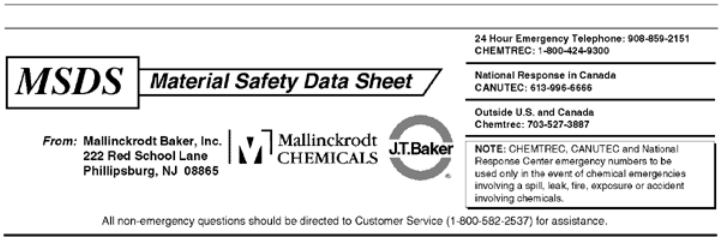
```
Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  Yes
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: No  Pressure: No
Reactivity: No          (Mixture / Liquid)
```

Australian Hazchem Code: 2R
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **1**
Label Hazard Warning:
POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG DAMAGE.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe vapor or mist.
Use only with adequate ventilation.
Wash thoroughly after handling.
Store in a tightly closed container.
Remove and wash contaminated clothing promptly.
Label First Aid:
In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:
****
Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.
****
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **N3660** * * * * * *Effective Date:* ***11/18/09*** * * * * * *Supercedes:* ***11/07/08***



NITRIC ACID, 50-70%

1. Product Identification

Synonyms: Aqua Fortis; Azotic Acid; Nitric Acid 50%; Nitric Acid 65%; nitric acid 69-70%
CAS No.: 7697-37-2
Molecular Weight: 63.01
Chemical Formula: HNO3
Product Codes:
J.T. Baker: 5371, 5796, 5801, 5826, 5856, 5876, 5896, 9597, 9598, 9600, 9601, 9602, 9603, 9604, 9606, 9607, 9608, 9610, 9616, 9617, 9670, 9761
Mallinckrodt: 1409, 2704, 2705, 2706, 2707, 2716, 6623, H862, H988, H993, H998, V077, V650

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Nitric Acid	7697-37-2	50 - 70%	Yes
Water	7732-18-5	30 - 50%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 4 - Extreme (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Oxidizer)
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison.

Inhalation:
Corrosive! Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract.
Ingestion:
Corrosive! Swallowing nitric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract.

Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color.
Eye Contact:
Corrosive! Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Chronic Exposure:
Long-term exposure to concentrated vapors may cause erosion of teeth and lung damage. Long-term exposures seldom occur due to the corrosive properties of the acid.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders, eye disease, or cardiopulmonary diseases may be more susceptible to the effects of this substance.

4. First Aid Measures

Immediate first aid treatment reduces the health effects of this substance.
Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Can react with metals to release flammable hydrogen gas.
Explosion:
Reacts explosively with combustible organic or readily oxidizable materials such as: alcohols, turpentine, charcoal, organic refuse, metal powder, hydrogen sulfide, etc. Reacts with most metals to release hydrogen gas which can form explosive mixtures with air.
Fire Extinguishing Media:
Water spray may be used to keep fire exposed containers cool. Do not get water inside container.
Special Information:
Increases the flammability of combustible, organic and readily oxidizable materials. In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):

2 ppm (TWA), 4 ppm (STEL)
-ACGIH Threshold Limit Value (TLV):
2 ppm (TWA); 4 ppm (STEL)

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Nitric acid is an oxidizer and should not come in contact with cartridges and canisters that contain oxidizable materials, such as activated charcoal. Canister-type respirators using sorbents are ineffective.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Colorless to yellowish liquid.
Odor:
Suffocating, acrid.
Solubility:
Infinitely soluble.
Specific Gravity:
1.41
pH:
1.0 (0.1M solution)
% Volatiles by volume @ 21C (70F):
100 (as water and acid)
Boiling Point:
122C (252F)
Melting Point:
-42C (-44F)
Vapor Density (Air=1):
2-3
Vapor Pressure (mm Hg):
48 @ 20C (68F)
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Containers may burst when heated.
Hazardous Decomposition Products:
When heated to decomposition, emits toxic nitrogen oxides fumes and hydrogen nitrate. Will react with water or steam to produce heat and toxic and corrosive fumes.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
A dangerously powerful oxidizing agent, concentrated nitric acid is incompatible with most substances, especially strong bases, metallic powders, carbides, hydrogen sulfide, turpentine, and combustible organics.
Conditions to Avoid:
Light and heat.

11. Toxicological Information

Nitric acid: Inhalation rat LC50: 244 ppm (NO2)/30M; Investigated as a mutagen, reproductive effector. Oral (human) LDLo: 430 mg/kg.

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--------\Cancer Lists\----------------------------------------------------
                                  ---NTP Carcinogen---
Ingredient                        Known    Anticipated    IARC Category
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Nitric Acid (7697-37-2)	No	No	None
Water (7732-18-5)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: NITRIC ACID
Hazard Class: 8, 5.1
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 6.5GL

International (Water, I.M.O.)

Proper Shipping Name: NITRIC ACID
Hazard Class: 8, 5.1
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 6.5GL

International (Air, I.C.A.O.)

Proper Shipping Name: NITRIC ACID
Hazard Class: 8, 5.1
UN/NA: UN2031
Packing Group: II

Information reported for product/size:

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Nitric Acid (7697-37-2)	Yes	Yes	Yes	Yes
Water (7732-18-5)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.
Nitric Acid (7697-37-2)	Yes	Yes	No	Yes
Water (7732-18-5)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

	-SARA 302-		------SARA 313------	
Ingredient	RQ	TPQ	List	Chemical Catg.
Nitric Acid (7697-37-2)	1000	1000	Yes	No
Water (7732-18-5)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Nitric Acid (7697-37-2)	1000	No	No
Water (7732-18-5)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
Reactivity: No (Mixture / Liquid)

Australian Hazchem Code: 2PE
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **0** Other: **Oxidizer**
Label Hazard Warning:
POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe vapor or mist.
Use only with adequate ventilation.
Wash thoroughly after handling.
Keep from contact with clothing and other combustible materials.
Do not store near combustible materials.
Store in a tightly closed container.
Remove and wash contaminated clothing promptly.
Label First Aid:
In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 14.
Disclaimer:
****
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****
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

Material Safety Data Sheet
Methanol

ACC# 14280

Section 1 - Chemical Product and Company Identification

MSDS Name: Methanol
Catalog Numbers: AC167830000, AC167830025, AC167835000, AC176840000, AC176840010, AC176840025, AC176840250, AC176845000, AC177150000, AC177150010, AC177150025, AC177150050, AC177150051, AC177150250, AC177150251, AC268280000, AC268280010, AC268280025, AC325740000, AC325740010, AC325740025, AC326630000, AC326630010, AC326630025, AC326950000, AC326950010, AC326951000, AC326952500, AC327900000, AC327900010, AC364390000, AC364390010, AC364391000, AC364395000, AC413770000, AC413770040, AC413775000, AC423950000, AC423950010, AC423950040, AC423950200, AC423955000, AC610090040, AC610200040, AC610400010, AC61040019, AC61040050, AC61040050, AC610401000, AC61040115, AC61040115, AC61040200, AC61040200, AC610981000, AC611070040, AC615130025, S75162, S75163, S75959, S75965, S75965A, S75965HPLC, S93301, S93301A, S93302, S93302A, 19123467, A408-1, A408-4, A408-4LC, A408SK-4, A411-20, A411-4, A412-1, A412-20, A412-200, A412-200001, A412-200LC, A412-4, A412-4LC, A412-500, A412200001, A412CU-1300, A412FB-200, A412FB115, A412FB19, A412FB50, A412P-4, A412POP19, A412POPB-200, A412RB-200, A412RB-50, A412RB115, A412RS-200, A412RS115, A412RS19, A412RS28, A412RS50, A412SK-4, A412SS-115, A413-20, A413-200, A413-4, A413-500, A433F-1GAL, A433P-1GAL, A433P-4, A433P1GAL, A433S-20, A433S-200, A433S-4, A434-20, A450-4, A452-1, A452-4, A452-4LC, A452N1-19, A452N2-19, A452POP-200, A452POP50, A452RS-115, A452RS-19, A452RS-200, A452RS-28, A452RS-50, A452SK-1, A452SK-4, A452SS-19, A452SS-200, A452SS-28, A452SS-50, A453-1, A453-1LC, A453-4, A453-500, A454-1, A454-4, A454-4LC, A454RS-115, A454RS-200, A454RS-28, A454SK-4, A454SS-200, A454SS-28, A455-1, A456-1, A456-4, A457-4, A4574LC, A935-4, A935RB-200, A935RB200, A947-4, A947-4LC, A947POP-200, A947POP200, A947RS-115, A947RS-200, A947RS-28, A947SS-115, A947SS-200, A947SS-28, A947SS-50, BP1105-1, BP1105-4, BP1105SS19, BP1105SS28, HC4001GAL, NC9173853, NC9386568, NC9419923, NC9433033, NC9433739, NC9514454, NC9516446, NC9535777, NC9541632, NC9942270, SC95-1, SW2-1, TIA947-4, TIA947P-200, TIA947P-200L
Synonyms: Carbinol; Methyl alcohol; Methyl hydroxide; Monohydroxymethane; Wood alcohol; Wood naptha; Wood spirits; Columbian spirits; Methanol.
Company Identification:

Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410

For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
67-56-1	Methanol	> 99	200-659-6

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: APHA: 10 max clear liquid. Flash Point: 12 deg C.
Danger! Poison! May be fatal or cause blindness if swallowed. Vapor harmful. **Flammable liquid and vapor.** Harmful if swallowed, inhaled, or absorbed through the skin. Causes eye, skin, and respiratory tract irritation. May cause central nervous system depression. Cannot be made non-poisonous.
Target Organs: Eyes, nervous system, optic nerve.

Potential Health Effects

Eye: May cause painful sensitization to light. Methanol is a mild to moderate eye irritant. Inhalation, ingestion or skin absorption of methanol can cause significant disturbances in vision, including blindness.
Skin: Causes moderate skin irritation. May be absorbed through the skin in harmful amounts. Prolonged and/or repeated contact may cause defatting of the skin and dermatitis. Methanol can be absorbed through the skin, producing systemic effects that include visual disturbances.
Ingestion: May be fatal or cause blindness if swallowed. Aspiration hazard. Cannot be made non-poisonous. May cause gastrointestinal irritation with nausea, vomiting and diarrhea. May cause systemic toxicity with acidosis. May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma and possible death due to respiratory failure. May cause cardiopulmonary system effects.
Inhalation: Methanol is toxic and can very readily form extremely high vapor concentrations at room temperature. Inhalation is the most common route of occupational exposure. At first, methanol causes CNS depression with nausea, headache, vomiting, dizziness and incoordination. A time period with no obvious symptoms follows (typically 8-24 hrs). This latent period is followed by metabolic acidosis and severe visual effects which may include reduced reactivity and/or increased sensitivity to light, blurred, doubl and/or snowy vision, and blindness. Depending on the severity of exposure and the promptness of treatment, survivors may recover completely or may have permanent blindness, vision disturbances and/or nervous system effects.
Chronic: Prolonged or repeated skin contact may cause dermatitis. Chronic exposure may cause effects similar to those of acute exposure. Methanol is only very slowly eliminated from the body. Because of this slow elimination, methanol should be regarded as a cumulative poison. Though a single exposure may cause no effect, daily exposures may result in the accumulation of a harmful amount. Methanol has produced fetotoxicity in rats and teratogenicity in mice exposed by inhalation to high concentrations that did not produce significant maternal toxicity.

Section 4 - First Aid Measures

Eyes: In case of contact, immediately flush eyes with plenty of water for a t least 15 minutes. Get medical aid.
Skin: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid immediately. Wash clothing before reuse.
Ingestion: Potential for aspiration if swallowed. Get medical aid immediately. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If vomiting occurs naturally, have victim lean forward.
Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Effects may be delayed.
Antidote: Ethanol may inhibit methanol metabolism.

Section 5 - Fire Fighting Measures

General Information: Ethanol may inhibit methanol metabolism. As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Water may be ineffective. Material is lighter than water and a fire may be spread by the use of water. Vapors are heavier than air and may travel to a source of ignition and flash back. Vapors can spread along the ground and collect in low or confined areas.
Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam. Water may be ineffective. For large fires, use water spray, fog or alcohol-resistant foam. Do NOT use straight streams of water.
Flash Point: 12 deg C (53.60 deg F)
Autoignition Temperature: 455 deg C (851.00 deg F)
Explosion Limits, Lower:6.0 vol %
Upper: 31.00 vol %
NFPA Rating: (estimated) Health: 1; Flammability: 3; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Use water spray to disperse the gas/vapor. Remove all sources of ignition. Absorb spill using an absorbent, non-combustible material such as earth, sand, or vermiculite. Do not use combustible materials such as sawdust. Use a spark-proof tool. Provide ventilation. A vapor suppressing foam may be used to reduce vapors. Water spray may reduce vapor but may not prevent ignition in closed spaces.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Ground and bond containers when transferring material. Use spark-proof tools and explosion proof equipment. Avoid contact with eyes, skin, and clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Keep container tightly closed. Do not ingest or inhale. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames. Use only with adequate ventilation. Keep away from heat, sparks and flame. Avoid use in confined spaces.
Storage: Keep away from heat, sparks, and flame. Keep away from sources of ignition. Store in a cool, dry, well-ventilated area away from incompatible substances. Flammables-area. Keep containers tightly closed.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use explosion-proof ventilation equipment. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Methanol	200 ppm TWA; 250 ppm STEL; Skin - potential significant contribution to overall exposure by the cutaneous r oute	200 ppm TWA; 260 mg/m3 TWA 6000 ppm IDLH	200 ppm TWA; 260 mg/m3 TWA

OSHA Vacated PELs: Methanol: 200 ppm TWA; 260 mg/m3 TWA
Personal Protective Equipment
Eyes: Wear chemical splash goggles.
Skin: Wear butyl rubber gloves, apron, and/or clothing.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

Physical State: Clear liquid
Appearance: clear, colorless - APHA: 10 max
Odor: alcohol-like - weak odor
pH: Not available.
Vapor Pressure: 128 mm Hg @ 20 deg C
Vapor Density: 1.11 (Air=1)
Evaporation Rate:5.2 (Ether=1)
Viscosity: 0.55 cP 20 deg C
Boiling Point: 64.7 deg C @ 760 mmHg
Freezing/Melting Point:-98 deg C
Decomposition Temperature: Not available.
Solubility: miscible
Specific Gravity/Density:.7910 g/cm3 @ 20°C

Molecular Formula:CH4O
Molecular Weight:32.04

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: High temperatures, ignition sources, confined spaces.
Incompatibilities with Other Materials: Oxidizing agents, reducing agents, acids, alkali metals, potassium, sodium, metals as powders (e.g. hafnium, raney nickel), acid anhydrides, acid chlorides, powdered aluminum, powdered magnesium.
Hazardous Decomposition Products: Carbon monoxide, carbon dioxide, formaldehyde.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 67-56-1: PC1400000
LD50/LC50:
CAS# 67-56-1:
Draize test, rabbit, eye: 40 mg Moderate;
Draize test, rabbit, eye: 100 mg/24H Moderate;
Draize test, rabbit, skin: 20 mg/24H Moderate;
Inhalation, rabbit: LC50 = 81000 mg/m3/14H;
Inhalation, rat: LC50 = 64000 ppm/4H;
Oral, mouse: LD50 = 7300 mg/kg;
Oral, rabbit: LD50 = 14200 mg/kg;
Oral, rat: LD50 = 5600 mg/kg;
Skin, rabbit: LD50 = 15800 mg/kg;
.
Human LDLo Oral: 143 mg/kg; Human LDLo Oral: 428 mg/kg; Human TCLo Inhalation; 300 ppm caused visual field changes & headache; Monkey LDLo Skin: 393 mg/kg. Methanol is significantly less toxic to most experimental animals than humans, because most animal species metabolize methanol differently. Non-primate species do not ordinarily show symptoms of metabolic acidosis or the visual effects which have been observed in primates and humans.
Carcinogenicity:
CAS# 67-56-1: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: No information found
Teratogenicity: There is no human information available. Methanol is considered to be a potential developmental hazard based on animal data. In animal experiments, methanol has caused fetotoxic or teratogenic effects without maternal toxicity.
Reproductive Effects: See actual entry in RTECS for complete information.
Mutagenicity: See actual entry in RTECS for complete information.
Neurotoxicity: ACGIH cites neuropathy, vision and CNS under TLV basis.
Other Studies:

Section 12 - Ecological Information

Ecotoxicity: Fish: Fathead Minnow: 29.4 g/L; 96 Hr; LC50 (unspecified)Fish: Goldfish: 250 ppm; 11 Hr; resulted in deathFish: Rainbow trout: 8000 mg/L; 48 Hr; LC50 (unspecified)Fish: Rainbow trout: LC50 = 13-68 mg/L; 96 Hr.; 12 degrees CFish: Fathead Minnow: LC50 = 29400 mg/L; 96 Hr.; 25 degrees C, pH 7.63Fish: Rainbow trout: LC50 = 8000 mg/L; 48 Hr.; UnspecifiedBacteria: Phytobacterium phosphoreum: EC50 = 51,000-320,000 mg/L; 30 minutes; Microtox test No data available.
Environmental: Dangerous to aquatic life in high concentrations. Aquatic toxicity rating: TLm 96>1000 ppm. May be dangerous if it enters water intakes. Methyl alcohol is expected to biodegrade in soil and water very rapidly. This

product will show high soil mobility and will be degraded from the ambient atmosphere by the reaction with photochemically produced hyroxyl radicals with an estimated half-life of 17.8 days. Bioconcentration factor for fish (golden ide) < 10. Based on a log Kow of -0.77, the BCF value for methanol can be estimated to be 0.2.
Physical: No information available.
Other: No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series:
CAS# 67-56-1: waste number U154 (Ignitable waste).

Section 14 - Transport Information

	US DOT	Canada TDG
Shipping Name:	METHANOL	METHANOL
Hazard Class:	3	3
UN Number:	UN1230	UN1230
Packing Group:	II	II
Additional Info:		FLASHPOINT 11 C

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 67-56-1 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
CERCLA Hazardous Substances and corresponding RQs
CAS# 67-56-1: 5000 lb final RQ; 2270 kg final RQ
SARA Section 302 Extremely Hazardous Substances
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 67-56-1: immediate, fire.
Section 313
This material contains Methanol (CAS# 67-56-1, > 99%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.
Clean Air Act:
CAS# 67-56-1 is listed as a hazardous air pollutant (HAP).
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.
OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 67-56-1 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

California Prop 65

California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

T F

Risk Phrases:

R 11 Highly flammable.
R 23/24/25 Toxic by inhalation, in contact with skin and if swallowed.
R 39/23/24/25 Toxic : danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

Safety Phrases:

S 16 Keep away from sources of ignition - No smoking.
S 36/37 Wear suitable protective clothing and gloves.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S 7 Keep container tightly closed.

WGK (Water Danger/Protection)

CAS# 67-56-1: 1

Canada - DSL/NDSL

CAS# 67-56-1 is listed on Canada's DSL List.

Canada - WHMIS

This product has a WHMIS classification of B2, D1B, D2B.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

Canadian Ingredient Disclosure List

CAS# 67-56-1 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 7/21/1999
Revision #16 Date: 6/29/2007

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

LIQUINOX MSDS

Section 1 : MANUFACTURER INFORMATION

Supplier: Same as manufacturer.

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Manufacturer emergency phone number: 800-255-3924.
813-248-0585 (outside of the United States).

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Supplier MSDS date: 2005/02/24

D.O.T. Classification: Not regulated.

Section 2 : HAZARDOUS INGREDIENTS

C.A.S.	CONCENTRATION %	Ingredient Name	T.L.V.	LD/50	LC/50
25155-30-0	10-30	SODIUM DODECYLBENZENESULFONATE	NOT AVAILABLE	438 MG/KG RAT ORAL 1330 MG/KG MOUSE ORAL	NOT AVAILABLE

Section 3 : PHYSICAL / CHEMICAL CHARACTERISTICS

Physical state: Liquid.

Appearance & odor: Odourless.
Pale yellow.

Odor threshold (ppm): Not available.

Vapour pressure (mmHg): @ 20°C (68°F).
17

Vapour density (air=1): >1

Volatiles (%)

By volume: Not available.

Evaporation rate (butyl acetate = 1): < 1.

Boiling point (°C):	100 (212F)
Freezing point (°C):	Not available.
pH:	8.5
Specific gravity @ 20 °C:	(water = 1). 1.083
Solubility in water (%):	Complete.
Coefficient of water\oil dist.:	Not available.
VOC:	None

Section 4 : FIRE AND EXPLOSION HAZARD DATA

Flammability:	Not flammable.
Conditions of flammability:	Surrounding fire.
Extinguishing media:	Carbon dioxide, dry chemical, foam. Water Water fog.
Special procedures:	Self-contained breathing apparatus required. Firefighters should wear the usual protective gear. Use water spray to cool fire exposed containers.
Auto-ignition temperature:	Not available.
Flash point (°C), method:	None
Lower flammability limit (% vol):	Not applicable.
Upper flammability limit (% vol):	Not applicable.

Not available.

Sensitivity to mechanical impact:	Not available.
Hazardous combustion products:	Oxides of carbon (COx). Hydrocarbons.
Rate of burning:	Not available.
Explosive power:	Containers may rupture if exposed to heat or fire.

Section 5 : REACTIVITY DATA

Chemical stability:	Product is stable under normal handling and storage conditions.
Conditions of instability:	Extreme temperatures.
Hazardous polymerization:	Will not occur.
Incompatible substances:	Strong acids. Strong oxidizing agents.
Hazardous decomposition products:	See hazardous combustion products.

Section 6 : HEALTH HAZARD DATA

Route of entry:	Skin contact, eye contact, inhalation and ingestion.
Effects of Acute Exposure	
Eye contact:	May cause irritation.
Skin contact:	Prolonged and repeated contact may cause irritation.
Inhalation:	May cause headache and nausea.
Ingestion:	May cause vomiting and diarrhea. May cause gastric distress.
Effects of chronic exposure:	See effects of acute exposure.
LD50 of product, species & route:	> 5000 mg/kg rat oral.
LC50 of product, species & route:	Not available.
Exposure limit of material:	Not available.
Sensitization to product:	Not available.
Carcinogenic effects:	Not listed as a carcinogen.
Reproductive effects:	Not available.
Teratogenicity:	Not available.
Mutagenicity:	Not available.
Synergistic materials:	Not available.
Medical conditions aggravated by exposure:	Not available.
First Aid	
Skin contact:	Remove contaminated clothing. Wash thoroughly with soap and water. Seek medical attention if irritation persists.
Eye contact:	Check for and remove contact lenses. Flush eyes with clear, running water for 15 minutes while holding eyelids open: if irritation persists, consult a physician.
Inhalation:	Remove victim to fresh air. If irritation persists, seek medical attention.
Ingestion:	Do not induce vomiting, seek medical attention. Dilute with two glasses of water. Never give anything by mouth to an unconscious person.

Section 7 : PRECAUTIONS FOR SAFE HANDLING AND USE

Leak / Spill:	Contain the spill. Prevent entry into drains, sewers, and other waterways. Wear appropriate protective equipment. Small amounts may be flushed to sewer with water. Soak up with an absorbent material. Place in appropriate container for disposal. Notify the appropriate authorities as required.
Waste disposal:	In accordance with local and federal regulations.
Handling procedures and equipment:	Protect against physical damage. Avoid breathing vapors/mists. Wear personal protective equipment appropriate to task.

Wash thoroughly after handling.
Keep out of reach of children.
Avoid contact with skin, eyes and clothing.
Avoid extreme temperatures.
Launder contaminated clothing prior to reuse.

Storage requirements: Store away from incompatible materials.
Keep containers closed when not in use.

Section 8 : CONTROL MEASURES

Precautionary Measures

Gloves / Type:

Wear appropriate gloves.

Respiratory / Type: None required under normal use.

Eye / Type:

Safety glasses recommended.

Footwear / Type: Safety shoes per local regulations.

Clothing / Type: As required to prevent skin contact.

Other / Type: Eye wash facility should be in close proximity.
Emergency shower should be in close proximity.

Ventilation requirements: Local exhaust at points of emission.

For the following RAE Part Numbers:

600-0001-000, 600-0002-000

600-0002-001, 600-0026-000

600-0027-000, 600-0069-000

AIR LIQUIDE™

MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI and Canadian WHMIS Standards

1. PRODUCT IDENTIFICATION

CHEMICAL NAME; CLASS: NONFLAMMABLE GAS MIXTURE

Containing One or More of the Following Components in a Nitrogen Balance Gas: Oxygen 0-23.5%; Isobutylene, 0.0005-0.9%

SYNONYMS: Not Applicable
CHEMICAL FAMILY NAME: Not Applicable
FORMULA: Not Applicable
Document Number: 50054

Note: The Material Safety Data Sheet is for this gas mixture supplied in cylinders with 33 cubic feet (935 liters) or less gas capacity (DOT - 39 cylinders). This MSDS has been developed for various gas mixtures with the composition of components within the ranges listed in Section 2 (Composition and Information on Ingredients). Refer to the product label for information on the actual composition of the product.

PRODUCT USE:	Calibration of Monitoring and Research Equipment
SUPPLIER/MANUFACTURER'S NAME:	CALGAZ
ADDRESS:	821 Chesapeake Drive Cambridge, MD 21613
EMERGENCY PHONE:	CHEMTREC: 1-800-424-9300
BUSINESS PHONE:	1-410-228-6400
General MSDS Information**:**	1-713/868-0440
Fax on Demand:	1-800/231-1366

2. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	mole %	EXPOSURE LIMITS IN AIR					
			ACGIH-TLV		OSHA-PEL		NIOSH	OTHER
			TWA ppm	STEL ppm	TWA ppm	STEL ppm	IDLH ppm	ppm
Isobutylene	115-11-7	0.0005-0.9%	There are no specific exposure limits for Isobutylene.					
Oxygen	7782-44-7	0-23.5%	There are no specific exposure limits for Oxygen.					
Nitrogen	7727-37-9	Balance	There are no specific exposure limits for Nitrogen. Nitrogen is a simple asphyxiant (SA). Oxygen levels should be maintained above 19.5%.					

NE = Not Established. See Section 16 for Definitions of Terms Used.

NOTE (1): ALL WHMIS required information is included in appropriate sections based on the ANSI Z400.1-1998 format. This gas mixture has been classified in accordance with the hazard criteria of the CPR and the MSDS contains all the information required by the CPR.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: This is a colorless, odorless gas mixture. Releases of this gas mixture may produce oxygen-deficient atmospheres (especially in confined spaces or other poorly-ventilated environments); individuals in such atmospheres may be asphyxiated. Isobutylene, a component of this gas mixture, may cause drowsiness and other central nervous system effects in high concentrations; however, due to its low concentration in this gas mixture, this is unlikely to occur.

SYMPTOMS OF OVER-EXPOSURE BY ROUTE OF EXPOSURE: The most significant route of over-exposure for this gas mixture is by inhalation.

INHALATION: Due to the small size of an individual cylinder of this gas mixture, no unusual health effects from over-exposure to the product are anticipated under routine circumstances of use. The chief health hazard associated with this gas mixture is when this gas mixture contains less than 19.5% Oxygen and is released in a small, poorly-ventilated area (i.e. an enclosed or confined space). Under this circumstance, an oxygen-deficient environment may occur. Individuals breathing such an atmosphere may experience symptoms which include headaches, ringing in ears, dizziness, drowsiness, unconsciousness, nausea, vomiting, and depression of all the senses. Under some circumstances of over-exposure, death may occur. The effects associated with various levels of oxygen are as follows:

CONCENTRATION OF OXYGEN	OBSERVED EFFECT
12-16% Oxygen:	Breathing and pulse rate increase, muscular coordination slightly disturbed.
10-14% Oxygen:	Emotional upset, abnormal fatigue, disturbed respiration.
6-10% Oxygen:	Nausea, vomiting, collapse, or loss of consciousness.
Below 6%:	Convulsive movements, possible respiratory collapse, and death.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in Lay Terms. Over-exposure to this gas mixture may cause the following health effects:

ACUTE: Due to the small size of the individual cylinder of this gas mixture, no unusual health effects from exposure to the product are anticipated under routine circumstances of use. The most significant hazard associated with this gas mixture when it contains less than 19.5% oxygen is the potential for exposure to oxygen-deficient atmospheres. Symptoms of oxygen deficiency include respiratory difficulty, ringing in ears, headaches, shortness of breath, wheezing, headache, dizziness, indigestion, nausea, unconsciousness, and death. The skin of a victim of over-exposure may have a blue color. Additionally, Isobutylene, a component of this gas mixture, may cause drowsiness or central nervous system effects in high concentrations; however, due to its low concentration in this gas mixture, this is unlikely to occur.

CHRONIC: Chronic exposure to oxygen-deficient atmospheres (below 18% oxygen in air) may affect the heart and nervous system.

TARGET ORGANS: ACUTE: Respiratory system, eyes. CHRONIC: Heart, cardiovascular system, central nervous system.

HAZARDOUS MATERIAL IDENTIFICATION SYSTEM

HEALTH HAZARD	(BLUE)	1
FLAMMABILITY HAZARD	(RED)	0
PHYSICAL HAZARD	(YELLOW)	0

PROTECTIVE EQUIPMENT

EYES	RESPIRATORY	HANDS	BODY
See Section 8			

For Routine Industrial Use and Handling Applications

4. FIRST-AID MEASURES

RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO THIS GAS MIXTURE WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus must be worn.

No unusual health effects are anticipated after exposure to this gas mixture, due to the small cylinder size. If any adverse symptom develops after over-exposure to this gas mixture, remove victim(s) to fresh air as quickly as possible. Only trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation if necessary. Victim(s) who experience any adverse effect after over-exposure to this gas mixture must be taken for medical attention. Rescuers should be taken for medical attention if necessary. Take a copy of the label and the MSDS to physician or other health professional with victim(s).

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Acute or chronic respiratory conditions may be aggravated by over-exposure to this gas mixture.

RECOMMENDATIONS TO PHYSICIANS: Administer oxygen, if necessary; treat symptoms and eliminate exposure.

5. FIRE-FIGHTING MEASURES

FLASH POINT: Not applicable.

AUTOIGNITION TEMPERATURE: Not applicable.

FLAMMABLE LIMITS (in air by volume, %):

Lower (LEL): Not applicable.
Upper (UEL): Not applicable.

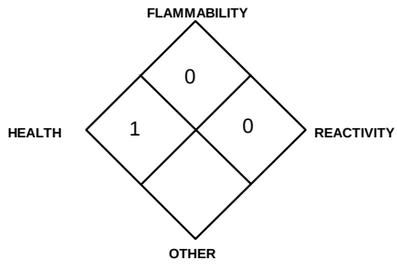
FIRE EXTINGUISHING MATERIALS: Non-flammable gas mixture. Use extinguishing media appropriate for surrounding fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS: This gas mixture is not flammable; however, containers, when involved in fire, may rupture or burst in the heat of the fire.

Explosion Sensitivity to Mechanical Impact: Not sensitive.
Explosion Sensitivity to Static Discharge: Not sensitive.

SPECIAL FIRE-FIGHTING PROCEDURES: Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment.

NFPA RATING



6. ACCIDENTAL RELEASE MEASURES

LEAK RESPONSE: Due to the small size and content of the cylinder, an accidental release of this gas mixture presents significantly less risk of an oxygen deficient environment and other safety hazards than a similar release from a larger cylinder. However, as with any chemical release, extreme caution must be used during emergency response procedures. In the event of a release in which the atmosphere is unknown, and in which other chemicals are potentially involved, evacuate immediate area. Such releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a leak, clear the affected area, protect people, and respond with trained personnel.

Allow the gas mixture to dissipate. If necessary, monitor the surrounding area (and the original area of the release) for oxygen. Oxygen levels must be above 19.5% before non-emergency personnel are allowed to re-enter area.

If leaking incidentally from the cylinder, contact your supplier.

7. HANDLING and USE

WORK PRACTICES AND HYGIENE PRACTICES: Be aware of any signs of dizziness or fatigue; exposures to fatal concentrations of this gas mixture could occur without any significant warning symptoms, due to oxygen deficiency. Do not attempt to repair, adjust, or in any other way modify the cylinders containing this gas mixture. If there is a malfunction or another type of operational problem, contact nearest distributor immediately.

STORAGE AND HANDLING PRACTICES: Cylinders should be firmly secured to prevent falling or being knocked-over. Cylinders must be protected from the environment, and preferably kept at room temperature (approximately 21°C [70°F]). Cylinders should be stored in dry, well-ventilated areas, away from sources of heat, ignition, and direct sunlight. Protect cylinders against physical damage. Full and empty cylinders should be segregated. Use a first-in, first-out inventory system to prevent full containers from being stored for long periods of time. These cylinders are not refillable. **WARNING! Do not refill DOT 39 cylinders. To do so may cause personal injury or property damage.**

SPECIAL PRECAUTIONS FOR HANDLING GAS CYLINDERS: WARNING! Compressed gases can present significant safety hazards. During cylinder use, use equipment designed for these specific cylinders. Ensure all lines and equipment are rated for proper service pressure.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain that application equipment is locked and tagged-out safely. Always use product in areas where adequate ventilation is provided.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: No special ventilation systems or engineering controls are needed under normal circumstances of use. As with all chemicals, use this gas mixture in well-ventilated areas. If this gas mixture is used in a poorly-ventilated area, install automatic monitoring equipment to detect the levels of Nitrous Oxide and Oxygen.

RESPIRATORY PROTECTION: No special respiratory protection is required under normal circumstances of use. Maintain oxygen levels above 19.5% in the workplace. Use supplied air respiratory protection when oxygen levels are below 19.5%, or during emergency response to a release of this gas mixture. During an emergency situation, before entering the area, check the concentration of Methane and Oxygen. If respiratory protection is needed, use only protection authorized in the U.S. Federal OSHA Standard (29 CFR 1910.134), applicable U.S. State regulations, or the Canadian CSA Standard Z94.4-93 and applicable standards of Canadian Provinces. Oxygen levels below 19.5% are considered IDLH by OSHA. In such atmospheres, use of a full-facepiece pressure/demand SCBA or a full facepiece, supplied air respirator with auxiliary self-contained air supply is required under OSHA's Respiratory Protection Standard (1910.134-1998).

EYE PROTECTION: Safety glasses. If necessary, refer to U.S. OSHA 29 CFR 1910.133 or appropriate Canadian Standards.

HAND PROTECTION: Wear leather gloves when handling cylinders. Chemically resistant gloves should be worn when using this gas mixture. If necessary, refer to U.S. OSHA 29 CFR 1910.138 or appropriate Standards of Canada.

BODY PROTECTION: No special protection is needed under normal circumstances of use. If a hazard of injury to the feet exists due to falling objects, rolling objects, where objects may pierce the soles of the feet or where employee's feet may be exposed to electrical hazards, use foot protection, as described in U.S. OSHA 29 CFR 1910.136.

9. PHYSICAL and CHEMICAL PROPERTIES

The following information is for Nitrogen, a main component of this gas mixture.

GAS DENSITY @ 32°F (0°C) and 1 atm: 0.072 lbs/ ft^3 (1.153 kg/m^3)
BOILING POINT: -195.8°C (-320.4°F)
FREEZING/MELTING POINT @ 10 psig: -210°C (-345.8°F)
SPECIFIC GRAVITY (air = 1) @ 70°F (21.1°C): 0.906
pH: Not applicable.
SOLUBILITY IN WATER vol/vol @ 32°F (0°C) and 1 atm: 0.023
MOLECULAR WEIGHT: 28.01
EVAPORATION RATE (nBuAc = 1): Not applicable.
EXPANSION RATIO: Not applicable.
ODOR THRESHOLD: Not applicable.
SPECIFIC VOLUME (ft^3/lb): 13.8
VAPOR PRESSURE @ 70°F (21.1°C) psig: Not applicable.
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.

The following information is for Oxygen, a main component of this gas mixture.

GAS DENSITY @ 32°F (0°C) and 1 atm: 0.083 lb/cu ft (1.326 kg/m^3)
FREEZING/MELTING POINT @ 10 psig: -218.8°C (-361.8°F)
BOILING POINT: -183.0°C (-297.4°F)
SPECIFIC GRAVITY (air = 1) @ 70°F (21.1°C): 1.105
pH: Not applicable.
SOLUBILITY IN WATER vol/vol at 32°F (0°C) and 1 atm: 0.04.91
MOLECULAR WEIGHT: 32.00
EVAPORATION RATE (nBuAc = 1): Not applicable.
EXPANSION RATIO: Not applicable.
ODOR THRESHOLD: Not applicable.
VOLUME (ft^3/lb): 12.1
VAPOR PRESSURE @ 70°F (21.1°C) psig: Not applicable.
COEFFICIENT WATER/OIL DISTRIBUTION: Not applicable.

The following information is for the gas mixture.

APPEARANCE AND COLOR: This is a colorless, odorless gas mixture.

HOW TO DETECT THIS SUBSTANCE (warning properties): There are no unusual warning properties associated with a release of this gas mixture. In terms of leak detection, fittings and joints can be painted with a soap solution to detect leaks, which will be indicated by a bubble formation.

10. STABILITY and REACTIVITY

STABILITY: Normally stable in gaseous state.
DECOMPOSITION PRODUCTS: The thermal decomposition products of Isobutylene include carbon oxides. The other components of this gas mixture do not decompose, per se, but can react with other compounds in the heat of a fire.
MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Titanium will burn in the Nitrogen component of this gas mixture. Lithium reacts slowly with Nitrogen at ambient temperatures. The Isobutylene component of this gas mixture is also incompatible with strong oxidizers (i.e. chlorine, bromine pentafluoride, oxygen difluoride, and nitrogen trifluoride).
HAZARDOUS POLYMERIZATION: Will not occur.
CONDITIONS TO AVOID: Contact with incompatible materials. Cylinders exposed to high temperatures or direct flame can rupture or burst.

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: The following toxicology data are available for the components of this gas mixture:

ISOBUTYLENE:
LC_{50} (inhalation, rat) = 620,000 mg/kg/4 hours
LC_{50} (inhalation, mouse) = 415,000 mg/kg
NITROGEN:
There are no specific toxicology data for Nitrogen. Nitrogen is a simple asphyxiant, which acts to displace oxygen in the environment.

SUSPECTED CANCER AGENT: The components of this gas mixture are not found on the following lists: FEDERAL OSHA Z LIST, NTP, CAL/OSHA, and IARC; therefore, they are not considered to be, nor suspected to be, cancer-causing agents by these agencies.
IRRITANCY OF PRODUCT: Contact with rapidly expanding gases can be irritating to exposed skin and eyes.
SENSITIZATION TO THE PRODUCT: The components of this gas mixture are not known to cause human skin or respiratory sensitization.
REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of this gas mixture and its components on the human reproductive system.

Mutagenicity: No mutagenicity effects have been described for the components in this gas mixture.
Embryotoxcity: No embryotoxic effects have been described for the components in this gas mixture.
Teratogenicity: No teratogenicity effects have been described for the components in this gas mixture.
Reproductive Toxicity: No reproductive toxicity effects have been described for the components in gas mixture.

A mutagen is a chemical which causes permanent changes to genetic material (DNA) such that the changes will propagate through generation lines. An embryotoxin is a chemical which causes damage to a developing embryo (i.e. within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A teratogen is a chemical which causes damage to a developing fetus, but the damage does not propagate across generational lines. A reproductive toxin is any substance which interferes in any way with the reproductive process.
BIOLOGICAL EXPOSURE INDICES (BEIs): Currently, Biological Exposure Indices (BEIs) are not applicable for the components of this gas mixture.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: The components of this gas mixture occur naturally in the atmosphere. The gas will be dissipated rapidly in well-ventilated areas. The following environmental data are applicable to the components of this gas mixture.

OXYGEN: Water Solubility = 1 volume Oxygen/32 volumes water at 20°C. Log K_{ow} = -0.65
NITROGEN: Water Solubility = 2.4 volumes Nitrogen/100 volumes water at 0°C. 1.6 volumes Nitrogen/100 volumes water at 20°C.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: No evidence is currently available on the effects of this gas mixture on plant and animal life.
EFFECT OF CHEMICAL ON AQUATIC LIFE: No evidence is currently available on the effects of this gas mixture on aquatic life.

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. Cylinders with undesired residual product may be safely vented outdoors with the proper regulator. For further information, refer to Section 16 (Other Information).

14. TRANSPORTATION INFORMATION

THIS GAS MIXTURE IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

PROPER SHIPPING NAME: Compressed gases, n.o.s. (*Oxygen, Nitrogen)*or the gas component with the next highest concentration next to Nitrogen.
HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER: UN 1956
PACKING GROUP: Not applicable.
DOT LABEL(S) REQUIRED: Class 2.2 (Non-Flammable Gas)
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 126
MARINE POLLUTANT: The components of this gas mixture are not classified by the DOT as Marine Pollutants (as defined by 49 CFR 172.101, Appendix B).
SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position, in a well-ventilated vehicle. The transportation of compressed gas cylinders in automobiles or in closed-body vehicles can present serious safety hazards. If transporting these cylinders in vehicles, ensure these cylinders are not exposed to extremely high temperatures (as may occur in an enclosed vehicle on a hot day). Additionally, the vehicle should be well-ventilated during transportation.
Note: DOT 39 Cylinders ship in a strong outer carton (overpack). Pertinent shipping information goes on the outside of the overpack. DOT 39 Cylinders do not have transportation information on the cylinder itself.

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: This gas is considered as Dangerous Goods, per regulations of Transport Canada.

PROPER SHIPPING NAME: Compressed gases, n.o.s. (*Oxygen, Nitrogen)*or the gas component with the next highest concentration next to Nitrogen.
HAZARD CLASS NUMBER and DESCRIPTION: 2.2 (Non-Flammable Gas)
UN IDENTIFICATION NUMBER: UN 1956
PACKING GROUP: Not Applicable
HAZARD LABEL: Class 2.2 (Non-Flammable Gas)
SPECIAL PROVISIONS: None
EXPLOSIVE LIMIT AND LIMITED QUANTITY INDEX: 0.12
ERAP INDEX: None
PASSENGER CARRYING SHIP INDEX: None
PASSENGER CARRYING ROAD VEHICLE OR PASSENGER CARRYING RAILWAY VEHICLE INDEX: 75
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2000): 126
NOTE: Shipment of compressed gas cylinders via Public Passenger Road Vehicle is a violation of Canadian law (Transport Canada Transportation of Dangerous Goods Act, 1992).

15. REGULATORY INFORMATION

ADDITIONAL U.S. REGULATIONS:
U.S. SARA REPORTING REQUIREMENTS: The components of this gas mixture are not subject to the reporting requirements of Sections 302, 304, and 313 of Title III of the Superfund Amendments and Reauthorization Act.
U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for this gas mixture. The default Federal MSDS submission and inventory requirement filing threshold of 10,000 lb (4,540 kg) may apply, per 40 CFR 370.20.
U.S. TSCA INVENTORY STATUS: The components of this gas mixture are listed on the TSCA Inventory.
U.S. CERCLA REPORTABLE QUANTITY (RQ): Not applicable.
OTHER U.S. FEDERAL REGULATIONS:

- No component of this gas mixture is subject to the requirements of CFR 29 1910.1000 (under the 1989 PELs).
- Isobutylene is subject to the reporting requirements of Section 112(r) of the Clean Air Act. The Threshold Quantity for this gas is 10,000 pounds.
- The regulations of the Process Safety Management of Highly Hazardous Chemicals are not applicable (29 CFR 1910.119).
- This gas mixture does not contain any Class I or Class II ozone depleting chemicals (40 CFR Part 82).

15. REGULATORY INFORMATION (continued)

- Nitrogen and Oxygen are not listed as Regulated Substances, per 40 CFR, Part 68, of the Risk Management for Chemical Releases. Isobutylene is listed under this regulation in Table 3 as Regulated Substances (Flammable Substances), in quantities of 10,000 lbs (4,554 kg) or greater.

U.S. STATE REGULATORY INFORMATION: The components of this gas mixture are covered under the following specific State regulations:

Alaska - Designated Toxic and Hazardous Substances: No.
California - Permissible Exposure Limits for Chemical Contaminants: Nitrogen.
Florida - Substance List: Oxygen, Isobutylene.
Illinois - Toxic Substance List: No.
Kansas - Section 302/313 List: No.
Massachusetts - Substance List: Oxygen, Isobutylene.
Michigan - Critical Materials Register: No.
Minnesota - List of Hazardous Substances: No.
Missouri - Employer Information/Toxic Substance List: No.
New Jersey - Right to Know Hazardous Substance List: Oxygen, Nitrogen, Isobutylene.
North Dakota - List of Hazardous Chemicals, Reportable Quantities: No.
Pennsylvania - Hazardous Substance List: Oxygen, Nitrogen, Isobutylene.
Rhode Island - Hazardous Substance List: Oxygen, Nitrogen.
Texas - Hazardous Substance List: No.
West Virginia - Hazardous Substance List: No.
Wisconsin - Toxic and Hazardous Substances: : No.

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): No component of this gas mixture is on the California Proposition 65 lists.

ADDITIONAL CANADIAN REGULATIONS:
CANADIAN DSL/NDSL INVENTORY STATUS: The components of this gas mixture are listed on the DSL Inventory.
CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS: The components of this gas mixture are not on the CEPA Priorities Substances Lists.
CANADIAN WHMIS REGULATIONS: This gas mixture is categorized as a Controlled Product, Hazard Class A, as per the Controlled Product Regulations.

16. OTHER INFORMATION

INFORMATION ABOUT DOT-39 NRC (Non-Refillable Cylinder) PRODUCTS

DOT 39 cylinders ship as hazardous materials when full. Once the cylinders are relieved of pressure (empty) they are not considered hazardous material or waste. Residual gas in this type of cylinder is not an issue because toxic gas mixtures are prohibited. Calibration gas mixtures typically packaged in these cylinders are Nonflammable n.o.s., UN 1956. A small percentage of calibration gases packaged in DOT 39 cylinders are flammable or oxidizing gas mixtures.

For disposal of used DOT-39 cylinders, it is acceptable to place them in a landfill if local laws permit. Their disposal is no different than that employed with other DOT containers such as spray paint cans, household aerosols, or disposable cylinders of propane (for camping, torch etc.). When feasible, we recommended recycling for scrap metal content. CALGAZ will do this for any customer that wishes to return cylinders to us prepaid. All that is required is a phone call to make arrangements so we may anticipate arrival. Scrapping cylinders involves some preparation before the metal dealer may accept them. We perform this operation as a service to valued customers who want to participate.

MIXTURES: When two or more gases or liquefied gases are mixed, their hazardous properties may combine to create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an Industrial Hygienist or other trained person when you make your safety evaluation of the end product. Remember, gases and liquids have properties which can cause serious injury or death.

Further information about the handling of compressed gases can be found in the following pamphlets published by: Compressed Gas Association Inc. (CGA), 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4102. Telephone: (703) 412-0900.

P-1 *"Safe Handling of Compressed Gases in Containers"*
AV-1 *"Safe Handling and Storage of Compressed Gases"*
"Handbook of Compressed Gases"

PREPARED BY: CHEMICAL SAFETY ASSOCIATES, Inc.
PO Box 3519, La Mesa, CA 91944-3519
619/670-0609
Fax on Demand: 1-800/231-1366

AIR LIQUIDE™

This Material Safety Data Sheet is offered pursuant to OSHA's Hazard Communication Standard, 29 CFR, 1910.1200. Other government regulations must be reviewed for applicability to this gas mixture. To the best of CALGAZ knowledge, the information contained herein is reliable and accurate as of this date; however, accuracy, suitability or completeness are not guaranteed and no warranties of any type, either express or implied, are provided. The information contained herein relates only to this specific product. If this gas mixture is combined with other materials, all component properties must be considered. Data may be changed from time to time. Be sure to consult the latest edition.

MSDS Number: **P1949** * * * * * *Effective Date:* ***05/19/08*** * * * * * *Supercedes:* ***08/24/05***

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

PHENOL, CRYSTALS

1. Product Identification

Synonyms: Carbolic acid; Phenic acid; Phenylic acid; Hydroxybenzene; Phenol, fused; Monohydroxybenzene; Phenol, solid
CAS No.: 108-95-2
Molecular Weight: 94.11
Chemical Formula: C6H5OH
Product Codes:
J.T. Baker: 2858, 2862, 4056
Mallinckrodt: 0028, 0052, 0273, 0605, H602

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Phenol	108-95-2	99 - 100%	Yes

3. Hazards Identification

Emergency Overview

POISON! DANGER! MAY BE FATAL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. RAPIDLY ABSORBED THROUGH SKIN. CORROSIVE. CAUSES SEVERE BURNS TO EVERY AREA OF CONTACT. AFFECTS CENTRAL NERVOUS SYSTEM, LIVER AND KIDNEYS. COMBUSTIBLE.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 2 - Moderate
Reactivity Rating: 1 - Slight
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER

Storage Color Code: White Stripe (Store Separately)

Potential Health Effects

The major hazard of phenol is its ability to penetrate the skin rapidly, particularly when liquid, causing severe injury which can be fatal. Phenol also has a strong corrosive effect on body tissue causing severe chemical burns. Due to its local anesthetizing properties, skin burns may be painless.

Inhalation:
Breathing vapor, dust or mist results in digestive disturbances (vomiting, difficulty in swallowing, diarrhea, loss of appetite). Will irritate, possibly burn respiratory tract. Other symptoms listed under ingestion may also occur.
Ingestion:

Poison. Symptoms may include burning pain in mouth and throat, abdominal pain, nausea, vomiting, headache, dizziness, muscular weakness, central nervous system effects, increase in heart rate, irregular breathing, coma, and possibly death. Acute exposure is also associated with kidney and liver damage. Ingestion of 1 gram has been lethal to humans.

Skin Contact:
Corrosive. Rapidly absorbed through the skin with systemic poisoning effects to follow. Discoloration and severe burns may occur, but may be disguised by a loss in pain sensation.

Eye Contact:
Corrosive. Eye burns with redness, pain, blurred vision may occur. May cause severe damage and blindness.

Chronic Exposure:
Repeated exposure may cause symptoms described for acute poisoning as well as eye and skin discoloration.

Aggravation of Pre-existing Conditions:
Persons with pre-existing skin, eye or central nervous system disorders, or impaired liver, kidney, or pulmonary function may be more susceptible to the effects of this substance.

4. First Aid Measures

IN CASE OF PHENOL POISONING, start first aid treatment immediately, then get medical attention. People administering first aid should take precautions to avoid contact with phenol. A phenol antidote kit (castor oil or other vegetable oil, polyethylene glycol 300) should be available in any phenol work area. Actions to be taken in case of phenol poisoning should be planned and practiced before beginning work with phenol. Castor oil and or polyethylene glycol can be given by a first responder before medical help arrives.

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Ingestion:
If swallowed, immediately administer castor oil or other vegetable oil. Never give anything by mouth to an unconscious person. Be ready to induce vomiting at the advice of physician or poison control center. Castor oil (or vegetable oil) dosage should be between 15 and 30 cc. Get medical attention immediately.

Skin Contact:
In case of skin contact, immediately flush skin with large amounts of water while removing contaminated clothing and shoes. As soon as possible, repeatedly apply polyethylene glycol to affected area. Destroy contaminated clothing and shoes. Flush skin with water for at least 30 minutes. It is very important to avoid rubbing or wiping affected parts which would aggravate irritation and cause product dispersion. Continue treatment until the burned area changes color from white to pink. Expect that this can take a long period of time (20 minutes or more). The polyethylene glycol application should be done during transportation to the hospital. If polyethylene glycol is not available, flush with water for at least 30 minutes prior to going to hospital. Get medical attention immediately.

Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Note to Physician:
Treat ingestion with gastric lavage using 40% aqueous Bacto-Peptone, milk or water until phenolic odor is eliminated. Then give 15 to 50 cc castor or vegetable oil. Debride necrotic skin. Monitor vital signs, fluid status, electrolytes, BUN, renal and hepatic function, and electrocardiogram. Manage sedation, seizures, renal failure, and fluid electrolyte imbalances symptomatically as indicated.

5. Fire Fighting Measures

Fire:
Flash point: 79C (174F) CC
Autoignition temperature: 715C (1319F)
Flammable limits in air % by volume:
lel: 1.3; uel: 8.6
Combustible. Contact with strong oxidizers may cause fire.

Explosion:
Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Sealed containers may rupture when heated.

Fire Extinguishing Media:
Water spray, dry chemical, alcohol foam, or carbon dioxide. Water spray may be used to keep fire exposed containers cool.

Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Structural firefighter's protective clothing is ineffective for fires involving this material. Stay away from sealed containers.

6. Accidental Release Measures

Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container. Do not flush to the sewer. Dry lime or soda ash may be used on spill for neutralization. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container. Store in a cool, dry, ventilated area away from sources of heat or ignition. Protect against physical damage. Store separately from reactive or combustible materials, and out of direct sunlight. Avoid dust formation and control ignition sources. Employ grounding, venting and explosion relief provisions in accord with accepted engineering practices in any process capable of generating dust and/or static electricity. Empty only into inert or non-flammable atmosphere. Emptying contents into a non-inert atmosphere where flammable vapors may be present could cause a flash fire or explosion due to electrostatic discharge. All phenol workers should be properly trained on its hazards and the proper protective measures required. This training should also include emergency actions. All phenol operations should be enclosed to eliminate any potential exposure routes. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
Phenol:
-OSHA Permissible Exposure Limit (PEL):
5 ppm (TWA) (skin)

-ACGIH Threshold Limit Value (TLV):
5 ppm (TWA) (skin)
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, a full facepiece respirator with organic vapor cartridge and dust/mist filter may be worn up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact. Butyl rubber and neoprene are suitable materials for personal protective equipment.
Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Colorless to light pink crystals.
Odor:
Sharp, medicinal, sweet, tarry.
Solubility:
1 g/15 ml of water; very soluble in alcohol.
Specific Gravity:
1.06 @ 20C/4C
pH:
ca. 6.0 Aqueous solution
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
182C (360F)
Melting Point:
43C (109F)
Vapor Density (Air=1):
3.2
Vapor Pressure (mm Hg):
0.4 @ 20C (68F)
Evaporation Rate (BuAc=1):
< 0.01

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Heat will contribute to instability.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition. Toxic gases and vapors may be released if involved in a fire.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Oxidizers, aluminum chloride and nitrobenzene, calcium hypochlorite, butadiene, halogens, formaldehyde, mineral oxidizing acids, isocyanates, sodium nitrite and many other materials. Hot liquid phenol will attack aluminum, magnesium, lead, and zinc metals.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Oral rat LD50: 317 mg/Kg; skin rabbit LD50:630 mg/kg; inhalation rat LC50: 316 mg/m3; irritation data: skin rabbit, standard Draize, 500 mg/24H severe; eye rabbit, standard Draize 5 mg/30S rinse, mild. Investigated as a tumorigen, mutagen, reproductive effector.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Phenol (108-95-2)	No	No	3

12. Ecological Information

Environmental Fate:
When released into the soil, this material is expected to readily biodegrade. When released into the soil, this material is not expected to leach into groundwater. When released into the soil, this material may evaporate to a moderate extent. When released into the soil, this material is expected to have a half-life between 1 and 10 days. When released into water, this material is expected to readily biodegrade. When released into water, this material is not expected to evaporate significantly. When released into water, this material is expected to have a half-life between 10 and 30 days. This material has an estimated bioconcentration factor (BCF) of less than 100. This material is not expected to significantly bioaccumulate. When released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material may be moderately degraded by photolysis. When released into the air, this material is expected to have a half-life of less than 1 day.
Environmental Toxicity:
This material is expected to be toxic to aquatic life. The LC50/96-hour values for fish are between 10 and 100 mg/l.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: PHENOL, SOLID
Hazard Class: 6.1
UN/NA: UN1671
Packing Group: II
Information reported for product/size: 2.5KG

International (Water, I.M.O.)

Proper Shipping Name: PHENOL, SOLID
Hazard Class: 6.1
UN/NA: UN1671
Packing Group: II
Information reported for product/size: 2.5KG

15. Regulatory Information

```
--------\Chemical Inventory Status - Part 1\---------------------------------
Ingredient                                    TSCA  EC   Japan  Australia
----------------------------------------------  ----  ---  -----  ---------
Phenol (108-95-2)                              Yes  Yes   Yes      Yes

--------\Chemical Inventory Status - Part 2\---------------------------------
                                                      --Canada--
Ingredient                                    Korea  DSL   NDSL  Phil.
----------------------------------------------  -----  ---   ----  -----
Phenol (108-95-2)                              Yes   Yes   No     Yes

--------\Federal, State & International Regulations - Part 1\----------------
                                       -SARA 302-    ------SARA 313------
Ingredient                             RQ    TPQ     List  Chemical Catg.
--------------------------------------  ---   -----   ----  --------------
Phenol (108-95-2)                      1000  500*    Yes        No

--------\Federal, State & International Regulations - Part 2\----------------
                                                    -RCRA-    -TSCA-
Ingredient                             CERCLA     261.33     8(d)
--------------------------------------  ------     ------    ------
Phenol (108-95-2)                      1000       U188       No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: Yes Pressure: No
Reactivity: No          (Pure / Solid)
```

Australian Hazchem Code: 2X
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

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16. Other Information

NFPA Ratings: Health: **4** Flammability: **2** Reactivity: **0**
Label Hazard Warning:
POISON! DANGER! MAY BE FATAL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN. RAPIDLY ABSORBED THROUGH SKIN. CORROSIVE. CAUSES SEVERE BURNS TO EVERY AREA OF CONTACT. AFFECTS CENTRAL NERVOUS SYSTEM, LIVER AND KIDNEYS. COMBUSTIBLE.
Label Precautions:
Do not breathe dust.
Do not get in eyes, on skin, or on clothing.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Keep away from heat, sparks and flame.
Label First Aid:
IN ALL CASES, GET MEDICAL ATTENTION IMMEDIATELY. KEEP A PHENOL ANTIDOTE KIT in area of product use or storage. Administer castor oil and/or polyethylene glycol per pre-planned directions. If swallowed, immediately administer castor oil or other vegetable oil. Never give anything by mouth to an unconscious person. In case of skin contact, immediately flush skin with large amounts of water while removing contaminated clothing and shoes. As soon as possible, repeatedly apply polyethylene glycol to affected area. Destroy contaminated clothing and shoes. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes while lifting lower and upper eyelids.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:
****
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RELIANCE UPON THIS INFORMATION.
****

Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

Material Safety Data Sheet
Sodium Hydroxide Solution 0.01 N to 2 N

ACC# 40177

Section 1 - Chemical Product and Company Identification

MSDS Name: Sodium Hydroxide Solution 0.01 N to 2 N
Catalog Numbers: GILHYD20, SS272-1, SS272-20, SS274-1, SS274-4, SS276-1, SS276-20, SS276-20LC, SS276-4, SS278-1, SS282-1, SS282-4, SS284-1, SS284-4
Synonyms: Caustic soda; Lye.
Company Identification:
Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
7732-18-5	Water	96-99.96	231-791-2
1310-73-2	Sodium hydroxide	0.04-4.0	215-185-5

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: Clear liquid.
Danger! Eye contact may result in permanent eye damage. Causes burns by all exposure routes. Corrosive to aluminum.
Target Organs: Eyes, skin, mucous membranes.

Potential Health Effects

Eye: Causes eye burns. May cause lacrimation (tearing), blurred vision, and photophobia. May cause chemical conjunctivitis and corneal damage.
Skin: Causes skin burns. May cause deep, penetrating ulcers of the skin. May cause skin rash (in milder cases), and cold and clammy skin with cyanosis or pale color.
Ingestion: May cause severe and permanent damage to the digestive tract. Causes gastrointestinal tract burns. May cause perforation of the digestive tract. Causes severe pain, nausea, vomiting, diarrhea, and shock. May cause systemic effects.
Inhalation: Irritation may lead to chemical pneumonitis and pulmonary edema. Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma.

Causes chemical burns to the respiratory tract. Aspiration may lead to pulmonary edema. May cause systemic effects.
Chronic: Prolonged or repeated skin contact may cause dermatitis. Effects may be delayed.

Section 4 - First Aid Measures

Eyes: In case of contact, immediately flush eyes with plenty of water for a t least 15 minutes. Get medical aid immediately.
Skin: In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid immediately. Wash clothing before reuse.
Ingestion: If swallowed, do NOT induce vomiting. Get medical aid immediately. If victim is fully conscious, give a cupful of water. Never give anything by mouth to an unconscious person.
Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Use water spray to keep fire-exposed containers cool. Contact with metals may evolve flammable hydrogen gas.
Extinguishing Media: Use water spray to cool fire-exposed containers. Substance is noncombustible; use agent most appropriate to extinguish surrounding fire.
Flash Point: Not applicable.
Autoignition Temperature: Not applicable.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: (estimated) Health: 3; Flammability: 0; Instability: 1

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Provide ventilation.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Do not get in eyes, on skin, or on clothing. Keep container tightly closed. Discard contaminated shoes. Use only with adequate ventilation. Do not breathe spray or mist.

Storage: Keep container closed when not in use. Store in a cool, dry, well-ventilated area away from incompatible substances. Keep away from strong acids. Keep away from metals. Keep away from flammable liquids. Keep away from organic halogens.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use process enclosure, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Water	none listed	none listed	none listed
Sodium hydroxide	2 mg/m3 Ceiling	10 mg/m3 IDLH	2 mg/m3 TWA

OSHA Vacated PELs: Water: No OSHA Vacated PELs are listed for this chemical. Sodium hydroxide: No OSHA Vacated PELs are listed for this chemical.
Personal Protective Equipment
Eyes: Wear chemical splash goggles.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant respirator use.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance: Clear
Odor: none reported
pH: Alkaline
Vapor Pressure: 14 mm Hg
Vapor Density: >1.0
Evaporation Rate: Not available.
Viscosity: >1 (ether=1)
Boiling Point: 100 deg C
Freezing/Melting Point:0 deg C
Decomposition Temperature: Not available.
Solubility: Soluble.
Specific Gravity/Density:1.0
Molecular Formula: NaOH
Molecular Weight: Not available.

Section 10 - Stability and Reactivity

Chemical Stability: Stable at room temperature in closed containers under normal storage and handling conditions.

Conditions to Avoid: Excess heat.
Incompatibilities with Other Materials: Metals, acids, aluminum, zinc, tin.
Hazardous Decomposition Products: Toxic fumes of sodium oxide.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 7732-18-5: ZC0110000
CAS# 1310-73-2: WB4900000
LD50/LC50:
CAS# 7732-18-5:
Oral, rat: LD50 = >90 mL/kg;
.

CAS# 1310-73-2:
Draize test, rabbit, eye: 400 ug Mild;
Draize test, rabbit, eye: 1% Severe;
Draize test, rabbit, eye: 50 ug/24H Severe;
Draize test, rabbit, eye: 1 mg/24H Severe;
Draize test, rabbit, skin: 500 mg/24H Severe;
.

Carcinogenicity:
CAS# 7732-18-5: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 1310-73-2: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: No information found
Teratogenicity: No information found
Reproductive Effects: No information found
Mutagenicity: No information found
Neurotoxicity: No information found
Other Studies:

Section 12 - Ecological Information

No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: None listed.

Section 14 - Transport Information

	US DOT	Canada TDG
Shipping Name:	SODIUM HYDROXIDE SOLUTION	No information available.
Hazard Class:	8	
UN Number:	UN1824	
Packing Group:	III	

Section 15 - Regulatory Information

US FEDERAL

TSCA

CAS# 7732-18-5 is listed on the TSCA inventory.
CAS# 1310-73-2 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

CERCLA Hazardous Substances and corresponding RQs

CAS# 1310-73-2: 1000 lb final RQ; 454 kg final RQ

SARA Section 302 Extremely Hazardous Substances

None of the chemicals in this product have a TPQ.

SARA Codes

CAS # 1310-73-2: immediate, reactive.

Section 313 No chemicals are reportable under Section 313.

Clean Air Act:

This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

CAS# 1310-73-2 is listed as a Hazardous Substance under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 7732-18-5 is not present on state lists from CA, PA, MN, MA, FL, or NJ.
CAS# 1310-73-2 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

California Prop 65

California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

C

Risk Phrases:

R 34 Causes burns.

Safety Phrases:

S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S 37/39 Wear suitable gloves and eye/face protection.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

WGK (Water Danger/Protection)

CAS# 7732-18-5: No information available.
CAS# 1310-73-2: 1

Canada - DSL/NDSL

CAS# 7732-18-5 is listed on Canada's DSL List.
CAS# 1310-73-2 is listed on Canada's DSL List.

Canada - WHMIS

This product has a WHMIS classification of E.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

Canadian Ingredient Disclosure List

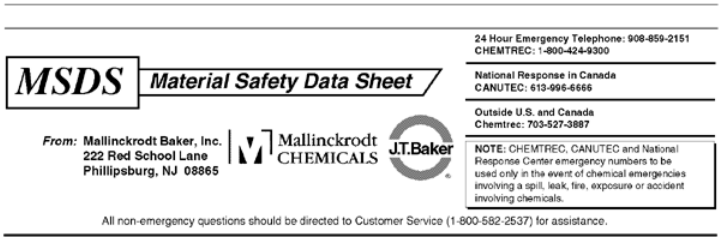
CAS# 1310-73-2 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 12/12/1997
Revision #10 Date: 11/06/2007

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

MSDS Number: **N3660** * * * * * *Effective Date:* ***11/18/09*** * * * * * *Supercedes:* ***11/07/08***



NITRIC ACID, 50-70%

1. Product Identification

Synonyms: Aqua Fortis; Azotic Acid; Nitric Acid 50%; Nitric Acid 65%; nitric acid 69-70%
CAS No.: 7697-37-2
Molecular Weight: 63.01
Chemical Formula: HNO3
Product Codes:
J.T. Baker: 5371, 5796, 5801, 5826, 5856, 5876, 5896, 9597, 9598, 9600, 9601, 9602, 9603, 9604, 9606, 9607, 9608, 9610, 9616, 9617, 9670, 9761
Mallinckrodt: 1409, 2704, 2705, 2706, 2707, 2716, 6623, H862, H988, H993, H998, V077, V650

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Nitric Acid	7697-37-2	50 - 70%	Yes
Water	7732-18-5	30 - 50%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 4 - Extreme (Poison)
Flammability Rating: 0 - None
Reactivity Rating: 3 - Severe (Oxidizer)
Contact Rating: 4 - Extreme (Corrosive)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: White (Corrosive)

Potential Health Effects

Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison.

Inhalation:
Corrosive! Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract.
Ingestion:
Corrosive! Swallowing nitric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract.

Skin Contact:
Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color.
Eye Contact:
Corrosive! Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Chronic Exposure:
Long-term exposure to concentrated vapors may cause erosion of teeth and lung damage. Long-term exposures seldom occur due to the corrosive properties of the acid.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders, eye disease, or cardiopulmonary diseases may be more susceptible to the effects of this substance.

4. First Aid Measures

Immediate first aid treatment reduces the health effects of this substance.
Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Can react with metals to release flammable hydrogen gas.
Explosion:
Reacts explosively with combustible organic or readily oxidizable materials such as: alcohols, turpentine, charcoal, organic refuse, metal powder, hydrogen sulfide, etc. Reacts with most metals to release hydrogen gas which can form explosive mixtures with air.
Fire Extinguishing Media:
Water spray may be used to keep fire exposed containers cool. Do not get water inside container.
Special Information:
Increases the flammability of combustible, organic and readily oxidizable materials. In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB® acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
-OSHA Permissible Exposure Limit (PEL):

2 ppm (TWA), 4 ppm (STEL)
-ACGIH Threshold Limit Value (TLV):
2 ppm (TWA); 4 ppm (STEL)

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Nitric acid is an oxidizer and should not come in contact with cartridges and canisters that contain oxidizable materials, such as activated charcoal. Canister-type respirators using sorbents are ineffective.
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Colorless to yellowish liquid.
Odor:
Suffocating, acrid.
Solubility:
Infinitely soluble.
Specific Gravity:
1.41
pH:
1.0 (0.1M solution)
% Volatiles by volume @ 21C (70F):
100 (as water and acid)
Boiling Point:
122C (252F)
Melting Point:
-42C (-44F)
Vapor Density (Air=1):
2-3
Vapor Pressure (mm Hg):
48 @ 20C (68F)
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Containers may burst when heated.
Hazardous Decomposition Products:
When heated to decomposition, emits toxic nitrogen oxides fumes and hydrogen nitrate. Will react with water or steam to produce heat and toxic and corrosive fumes.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
A dangerously powerful oxidizing agent, concentrated nitric acid is incompatible with most substances, especially strong bases, metallic powders, carbides, hydrogen sulfide, turpentine, and combustible organics.
Conditions to Avoid:
Light and heat.

11. Toxicological Information

Nitric acid: Inhalation rat LC50: 244 ppm (NO2)/30M; Investigated as a mutagen, reproductive effector. Oral (human) LDLo: 430 mg/kg.

```
--------\Cancer Lists\----------------------------------------------------
                                  ---NTP Carcinogen---
Ingredient                        Known    Anticipated    IARC Category
----------------------------------   -----    -----------    -------------
```

Nitric Acid (7697-37-2)	No	No	None
Water (7732-18-5)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: NITRIC ACID
Hazard Class: 8, 5.1
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 6.5GL

International (Water, I.M.O.)

Proper Shipping Name: NITRIC ACID
Hazard Class: 8, 5.1
UN/NA: UN2031
Packing Group: II
Information reported for product/size: 6.5GL

International (Air, I.C.A.O.)

Proper Shipping Name: NITRIC ACID
Hazard Class: 8, 5.1
UN/NA: UN2031
Packing Group: II

Information reported for product/size:

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Nitric Acid (7697-37-2)	Yes	Yes	Yes	Yes
Water (7732-18-5)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.
Nitric Acid (7697-37-2)	Yes	Yes	No	Yes
Water (7732-18-5)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

	-SARA 302-		------SARA 313------	
Ingredient	RQ	TPQ	List	Chemical Catg.
Nitric Acid (7697-37-2)	1000	1000	Yes	No
Water (7732-18-5)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Nitric Acid (7697-37-2)	1000	No	No
Water (7732-18-5)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
Reactivity: No (Mixture / Liquid)

Australian Hazchem Code: 2PE
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **3** Flammability: **0** Reactivity: **0** Other: **Oxidizer**
Label Hazard Warning:
POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.
Label Precautions:
Do not get in eyes, on skin, or on clothing.
Do not breathe vapor or mist.
Use only with adequate ventilation.
Wash thoroughly after handling.
Keep from contact with clothing and other combustible materials.
Do not store near combustible materials.
Store in a tightly closed container.
Remove and wash contaminated clothing promptly.
Label First Aid:
In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 14.
Disclaimer:
****
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****
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

ISO9001 - 2000 certified

Material Safety Data Sheet

Sulfuric Acid Solutions 0.03-93%, Sulfuric Acid Solutions 0.01N - 12N

Section 1 - Chemical Product and Company Identification

MSDS Name:

Sulfuric Acid Solutions 0.03-93%, Sulfuric Acid Solutions 0.01N - 12N

Catalog Numbers:

LC25570, LC25580, LC25590, LC25600, LC25605, LC25607, LC25610, LC25620, LC25640, LC25645, LC25650, LC25655, LC25660, LC25670, LC25675, LC25680, LC25685, LC25700, LC25720, LC25730, LC25740, LC25770, LC25790, LC25800, LC25810, LC25830, LC25840, LC25850, LC25870, LC25880

Synonyms:

Company Identification:

LabChem, Inc.
200 William Pitt Way
Pittsburgh, PA 15238

Company Phone Number:

(412) 826-5230

Emergency Phone Number:

(800) 424-9300

CHEMTREC Phone Number:

(800) 424-9300

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name:	Percent
7732-18-5	Water	balance
7664-93-9	Sulfuric acid	0.03-93

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: colorless
Danger! Corrosive. Causes eye and skin burns. Causes digestive and respiratory tract burns.
Target Organs: None.

Potential Health Effects

Eye:

Causes severe eye burns. Eye contact can result in blindness; exposure to mist leads to watering, irritation.

Skin:

Skin contact may result in severe burns, blistering, pain.

Material Safety Data Sheet

Sulfuric Acid Solutions 0.03-93%, Sulfuric Acid Solutions 0.01N - 12N

Ingestion:

May cause severe and permanent damage to the digestive tract. Causes gastrointestinal tract burns. Vomiting and diarrhea of dark blood may occur; asphyxia from throat swelling. Stomach and esophagus may become perforated.

Inhalation:

May cause severe irritation of the respiratory tract with sore throat, coughing, shortness of breath and delayed lung edema. Causes chemical burns to the respiratory tract. At 5mg/M3 concentrations, nose and throat irritation occurs, with headache, cough, increased respiratory rate, impairment of lung to ventilate.

Chronic:

Delayed symptoms include tight chest, fluid in lungs, cyanosis (blue color), hypotension, bronchitis or emphysema. tracheobronchitis, dental erosion/discoloration, pneumonia, gastrointestinal disturbances may occur. Skin irritation/dermatitis, conjunctivitis and lacrimation of the eye can occur.

Section 4 - First Aid Measures

Eyes:

Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids until chemical is gone. Get medical aid at once.

Skin:

Get medical aid at once. Immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.

Ingestion:

Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Get medical aid at once. Give one ounce (30ml) of milk of magnesia. Give conscious victim large quantities of water to dilute acid.

Inhalation:

Get medical aid at once. Move victim to fresh air immediately. Give artificial respiration if necessary. If breathing is difficult, give oxygen.

Notes to Physician:

Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information:

As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Contact with metals may evolve flammable hydrogen gas. Avoid breathing toxic and corrosive vapors - keep upwind.

Extinguishing Media:

Use extinguishing media most appropriate for the surrounding fire.

Autoignition Temperature:

No information found.

Flash Point:

No information found.

NFPA Rating:

CAS# 7732-18-5: Not published.
CAS# 7664-93-9: health - 3; flammability - 0; reactivity - 2.

Explosion Limits:

Lower: Upper:

Material Safety Data Sheet

Sulfuric Acid Solutions 0.03-93%, Sulfuric Acid Solutions 0.01N - 12N

Section 6 - Accidental Release Measures

General Information:

Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

May be neutralized with slaked lime, limestone, or sodium bicarbonate to a pH 7. Place in labeled plastic containers for disposal, wash area down with water.

Section 7 - Handling and Storage

Handling:

Wash thoroughly after handling. Do not get in eyes, on skin, or on clothing. Do not ingest or inhale. Use with adequate ventilation.

Storage:

Do not store near alkaline substances. Store in labeled non-reactive containers (glass, plastic) protected from heat and incompatible substances.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls:

Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Exposure Limits

Chemical Name:	ACGIH	NIOSH	OSHA
Water	None of the components are on this list.	None of the components are on this list.	None of the components are on this list.
Sulfuric acid	1 mg/m3 TWA;3 mg/m3 STEL	1 mg/m3 TWA	1 mg/m3 TWA;

OSHA Vacated PELs

Sulfuric acid: 1 mg/m3 TWA

Personal Protective Equipment

Eyes:

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133. Provide an eye-wash fountain in the immediate work area. Do not wear contact lenses when working with chemicals.

Skin:

Wear appropriate protective gloves to prevent skin exposure.

Clothing:

Wear acid protective clothing and gloves.

Respirators:

50mg/M3 -GMAGHiEP/HiEPF/SAF/SCBAF.
100mg/M3 - SAF:PD,PP,CF.
Escape - GMAGHiEP/SCBA. Firefighting - SCBAF:PD,PP.
(Respirator Codes: (NIOSH) PUblication No. 78-210)

Material Safety Data Sheet

Sulfuric Acid Solutions 0.03-93%, Sulfuric Acid Solutions 0.01N - 12N

Section 9 - Physical and Chemical Properties

Physical State:	Liquid
Color:	colorless
Odor:	odorless
pH:	acidic
Vapor Pressure:	No information found.
Vapor Density:	No information found.
Evaporation Rate:	<ether
Viscosity:	No information found.
Boiling Point:	No information found.
Freezing/Melting Point:	No information found.
Decomposition Temperature:	No information found.
Solubility in water:	Soluble.
Specific Gravity/Density:	1.0 - 1.7
Molecular Formula:	No information found.
Molecular Weight	No information found.

Section 10 - Stability and Reactivity

Chemical Stability:

Stable under normal temperatures and pressures.

Conditions to Avoid:

Incompatible materials, excess heat, combustible materials, organic materials, oxidizers, amines, bases.

Incompatibilities with Other Materials

Explosive or violent reactions with acetone cyanohydrin, acetone and nitric acid or potassium dichromate, acrylonitrile, alcohols, hydrogen peroxide, allyl chloride, bromates and metals, bromine pentafluoride, carbides, all chlorates, chlorine trifluoride, cuprous nitride, ethylene cyanohydrin, fulminates, indane and nitric acid, iron, mercuric nitride, nitric acid and glycerides, p-nitrotoluene, pentasilver trihydroxydiaminophosphate, perchlorates, phosphorus isocyanate picrates, sliver permanganate, sodium, sodium carbonate, toluene and nitric acid. Dangerous temperatures and pressures occur with other substances, especially organic combinations. Explosive hydrogen gas is evolved from contact with steel, other metals.

Hazardous Decomposition Products

Oxides of sulfur, hydrogen gas.

Hazardous Polymerization

Has not been reported.

Section 11 - Toxicological Information

RTECS:

CAS# 7732-18-5: ZC0110000.
CAS# 7664-93-9: WS5600000.

Material Safety Data Sheet

Sulfuric Acid Solutions 0.03-93%, Sulfuric Acid Solutions 0.01N - 12N

LD50/LC50:

CAS# 7732-18-5:
Oral, rat: LD50 = >90 mL/kg.
CAS# 7664-93-9:
Inhalation, mouse: LC50 =320 mg/m3/2H
Inhalation, rat: LC50 =510 mg/m3/2H
Oral, rat: LD50 = 2140 mg/kg.

Carcinogenicity:

CAS# 7732-18-5: Not listed as a carcinogen by ACGIH, IARC, NIOSH, NTP, OSHA, or CA Prop 65.
CAS# 7664-93-9
ACGIH: A2 - Suspected Human Carcinogen (contained in strong inorganic acid mists)
California: Not listed.
NIOSH: Not listed.
NTP: Not listed.
OSHA: Select carcinogen
IARC: Group 1 carcinogen

Epidemiology:

Teratogenicity:

Reproductive:

Mutagenicity

Neurotoxicity

Section 12 - Ecological Information

No information found.

Section 13 - Disposal Considerations

Dispose of in accordance with federal, state, and local regulations.

Section 14 - Transport Information

US DOT

	> 51% W/W	0.5% to 51% W/W	< 0.5% W/W
Shipping Name:	Sulfuric acid	Sulfuric Acid	Not regulated.
Hazard Class:	8	8	
UN Number:	UN1830	UN2796	
Packing Group:	PG II	PG II	

Section 15 - Regulatory Information

US Federal

TSCA

CAS# 7732-18-5 is listed on the TSCA Inventory.
CAS# 7664-93-9 is listed on the TSCA Inventory.

Material Safety Data Sheet

Sulfuric Acid Solutions 0.03-93%, Sulfuric Acid Solutions 0.01N - 12N

SARA Reportable Quantities (RQ)

CAS# 7664-93-9: final RQ = 1000 pounds (454 kg)

CERCLA/SARA Section 313

This material contains Sulfuric acid (CAS# 7664-93-9, 0.03-93%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

OSHA - Highly Hazardous

None of the components are on this list.

US State

State Right to Know

Sulfuric acid can be found on the following state Right-to-Know lists: California, New Jersey, Florida, Pennsylvania, Minnesota, Massachusetts.

California Regulations

European/International Regulations

Canadian DSL/NDSL

CAS# 7732-18-5 is listed on Canada's DSL List.
CAS# 7664-93-9 is listed on Canada's DSL List.

Canada Ingredient Disclosure List

CAS# 7732-18-5 is not listed on Canada's Ingredient Disclosure List.
CAS# 7664-93-9 is listed on Canada's Ingredient Disclosure List.

Section 16 - Other Information

MSDS Creation Date: November 9, 1997
Revision Date: November 11, 2004

Information in this MSDS is from available published sources and is believed to be accurate. No warranty, express or implied, is made and LabChem Inc. assumes no liability resulting from the use of this MSDS. The user must determine suitability of this information for his application.

APPENDIX B3

SITE-SPECIFIC FIELD SAMPLING PLAN

APPENDIX B3

SITE-SPECIFIC FIELD SAMPLING PLAN

NORTH STATION OPERABLE UNIT OF THE NORTH BRANCH SITE

Prepared for:

Peoples Gas Light and Coke Company

Managed by:

Integrys Business Support, LLC
130 East Randolph Drive
Chicago, Illinois 60601

Prepared For Use By:

Natural Resource Technology, Inc.

Revision 0
August 4, 2011

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FIGURES

Figure 1 Technical Team Strategy

ATTACHMENTS

Attachment 1: Field Sampling Forms

1 INTRODUCTION

1.1 Background

This Site-Specific Field Sampling Plan (FSP) was prepared in accordance with the Statement of Work (SOW) attached to the Settlement Agreement and Administrative Order on Consent (AOC) between the United States Environmental Protection Agency (USEPA) and The Peoples Gas Light and Coke Company (Peoples Gas), CERCLA Docket No. V-W-'08-C-917, effective October 31, 2008. The AOC/SOW addresses four former Manufactured Gas Plant (MGP) Sites operated by Peoples Gas and specifies that Remedial Investigations and Feasibility Studies (RI/FSs) be conducted on these Sites. The North Branch Site includes the Willow Street/Hawthorne Avenue Station Operable Unit (OU), the North Station OU and the Division Street Station OU. Each of the three OUs includes the portion of the North Branch of the Chicago River (the River) that is adjacent to the respective upland portion of the OU.

This Site-Specific FSP addresses the North Station OU of the North Branch Site.

Integrys Business Support, LLC (IBS) is managing the work in the AOC/SOW on behalf of Peoples Gas. Unless specifically noted, the relevant sections of the Multi-Site FSP Rev 4, dated September 8, 2008 will be used while implementing the Site-Specific Work Plan (SSWP) at the North Station OU. This Site-Specific FSP only includes portions of the Multi-Site FSP Rev 4 that require updating for site-specific work at the North Station OU.

1.2 Sampling Objectives

See Multi-Site FSP, Rev 4, September 8, 2008.

1.3 Site-Specific Work Plans

1.3.1 Technical Approach

The approach to determine sample locations, types, frequencies, collection methods and field analysis is discussed in Sections 4 and 6 and presented in Tables 1, 2 and 3 of the SSWP. Section 6 of the SSWP

also details the decision process and site knowledge that will be utilized on a real-time basis to determine sample type, location, frequency, and constituents.

1.3.1.1 Soil Sampling

In the case of soil, borings will be continuously sampled and a sample will be selected for chemical analyses based on the presence of impacts identified by PID readings, odors or visual observation. If no impacts are encountered and recovery is sufficient, a sample will be selected for analyses based on a random sample scheme, splitting up the sample depth into 1 foot increments.

Borings will generally be advanced a minimum of 5 feet below ground surface (bgs). Borings that are at least 5 feet deep and are advanced a minimum of 4 feet into native silty clay or clay can be terminated, unless additional advancement is necessary for delineation purposes. For example, if impacts were encountered inward at a depth of 30 feet bgs and a step out boring is advanced to confirm lateral extent, the step out boring must be advanced at least 30 feet bgs as well. If the soil boring indicates the presence of impacts in clay fractures at depth, the soil boring may be extended down to the base of the clay (estimated at 50 feet bgs) and may continue into bedrock if impacts within the core are consistent and present within 2 feet of the bedrock surface.

Soil characterization in the vicinity of utilities may use vacuum excavation to locate the utility and evaluate the bedding material. A hand auger boring may be installed adjacent to the vacuum excavation to log the soils and/or place a soil gas sampling probe in the bedding material of the utility.

Optional borings will be advanced when initial borings do not fully characterize the extent of impacts.

1.3.1.2 Soil Gas Sampling

The depth of soil gas probes will be near the surface of the water table. Depending on the depth to the water table, two probes and two soil samples will be collected; one near the water table and another half way up to grade. If probes are installed in buildings, a sub slab sample will also be collected.

Interior soil gas probes may be advanced with hand augers and/or hammer drill if access to the building basement or slab limits the use of larger equipment (e.g., direct push methods).

1.3.1.3 Groundwater

Groundwater monitoring wells are proposed to be installed in various locations. If groundwater is not encountered during soil boring advancement in a specific location, an off set will be attempted. If no water is present, some well locations may be cancelled.

Contingent well locations will be installed either to replace poor yield locations or to further define impacts. Perched water may be encountered and insufficient water may be present in this area of Chicago.

Monitoring wells may be placed in the bedrock (>50 feet bgs) if impacts are found in the bedrock or near the bedrock surface. If groundwater monitoring of bedrock is required, a minimum of 3 bedrock wells screened at similar elevations may be recommended to determine flow direction in the bedrock aquifer. Deep wells may require the use of outer casing during drilling to limit cross-contamination (i.e., drag-down) from the unlithified material into the bedrock.

1.3.1.4 Surface Water

Surface water sampling will be conducted in accordance with the SSWP.

1.3.1.5 Sediment

Sediment sampling and the dynamic process are described the SSWP.

1.3.2 Project Personnel

Figure 1 of this Site-Specific FSP presents technical team strategy and the key project staff responsible for project planning, data and decision quality and final work products, consistent with the Multi-Site Quality Assurance Project Plan (QAPP), Rev 2, dated September 4, 2007 (IBS 2007) and as modified in the Site-Specific QAPP. The Site-Specific QAPP is contained in an appendix to the SSWP.

1.3.3 Subcontractors

A list of subcontracted services will be provided to USEPA for review prior to initiating field work, in accordance with the Administrative Order on Consent/Statement of Work (AOC/SOW).

1.3.4 Decision-Making Processes

The SSWP provides the site-specific communication strategy, and identifies project communication flow, frequency and documentation requirements between potentially responsible parties/responsible parties, regulators, project managers, field personnel, contractors and others.

1.3.5 Decision-Making Processes

As discussed in Section 1.3.1 of this Site-Specific FSP, the decision-making process for field activities is provided in Section 6 and Table 4 of the SSWP.

1.3.6 Data Exchange

Section 6 and Table 4 of the SSWP describe the data required to make field decisions. Analytical data reports will be provided to USEPA in an electronic format in accordance with the Multi-Site QAPP (IBS 2007c). Data will be provided in the form of a monthly progress report submitted on the 15th day of each month, provided it has been validated. Data may also be provided in figures and tables for submittal with the progress report. The usability of previously collected data will be evaluated according to criteria specified in the Site-Specific QAPP. The Site-Specific Conceptual Site Model (CSM) will be refined as investigation data is generated and used to facilitate the RI. The RI Report will be submitted in accordance with the Project Schedule presented in the SSWP.

1.3.7 Field Sampling Forms

Updated field sampling forms for sediment sample collection, sediment poling and surface water sampling are provided in Attachment 1.

2 SAMPLE LOCATIONS

See Multi-Site FSP, Rev 4, September 8, 2008.

3 FIELD MOBILIZATION AND SITE ACCESS

See Multi-Site FSP, Rev 4, September 8, 2008.

4 DATA COLLECTION PROCEDURES

4.1 Field Standard Operating Procedures

See Multi-Site FSP, Rev 4, September 8, 2008.

4.2 Soil Sampling

See Multi-Site FSP, Rev 4, September 8, 2008.

4.2.1 Data Uses

Soil data may be collected from various depth intervals. Results from samples collected from the ground surface to 10 feet below ground surface (bgs) may be used to support the human health dermal and inhalation exposure routes, depending on the location of sampling. Deeper subsurface soil samples may be collected to evaluate the vertical extent of MGP residuals, to support a random sampling scheme if no impacts are observed, or to evaluate remedial alternatives, if required.

4.2.2 Surface Soil Samples

See Multi-Site FSP, Rev 4, September 8, 2008 and the SSWP for proposed locations of surface soil samples.

4.2.3 Subsurface Soil Samples

Subsurface soil is defined as soil at depths greater than 2 feet bgs. Samples will be collected as described in Sections 4 and 6 and Table 2, 3, and 4 of the SSWP. A guidance document for describing coal tar contamination in soil is included in Appendix J of the SSWP.

4.2.4 Test Pits

No test pits are planned as part of the SSWP.

4.2.5 Soil Borings

See Multi-Site FSP, Rev 4, September 8, 2008.

4.2.6 Subsurface Probes

No subsurface probes are planned as part of the SSWP.

4.2.7 Borehole Abandonment

Boreholes will be abandoned in accordance with 77 Illinois Administrative Code (IAC) Part 920.120.

4.3 Geophysical Methods

4.3.1 Overview

Geophysical data will be collected as part of the SSWP for sediment samples.

4.3.2 Upland Applications

No Upland geophysical data will be collected as part of the SSWP.

4.3.3 Sediment Applications

See Multi-Site FSP, Rev 4, September 8, 2008.

4.3.4 Base Mapping and Survey Control

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4 Groundwater Sampling

4.4.1 Overview

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4.2 Data Uses

Groundwater data will be collected to support the evaluation of human health dermal and ingestion exposure routes. Groundwater data will also be collected to evaluate groundwater quality at the surface water interface and to evaluate related vapor intrusion potential, if impacts are present.

4.4.3 Water Level Elevation Readings

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4.4 Groundwater Grab Samples

No groundwater grab samples are planned as part of the SSWP.

4.4.5 Monitoring Wells

4.4.5.1 Well Placement

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4.5.2 Well Screen Placement

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4.5.3 Temporary Monitoring Wells

No temporary monitoring wells are planned as part of the SSWP.

4.4.5.4 Small-Diameter Prepacked Monitoring Wells

No prepacked monitoring wells are planned as part of the SSWP.

4.4.5.5 Large-Diameter Monitoring Wells

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4.6 Monitoring Well Development

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4.7 Monitoring Well Groundwater Sampling

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4.7.1 Purging

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4.7.2 Sample Collection

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4.7.2.1 Bailer Sampling

Bailer sampling is not planned as part of the SSWP. If bailer sampling is opted for due to the presence of low-producing wells, see the Multi-Site FSP, Rev 4, September 8, 2008.

4.4.7.2.2 Low-Flow Sampling

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4.7.2.3 Diffusion Sampling

Diffusion sampling is not planned as part of the SSWP.

4.4.8 Potable Wells

No potable well samples are planned as part of the SSWP.

4.4.9 Aquifer Characterization

See Multi-Site FSP, Rev 4, September 8, 2008.

4.4.10 Monitoring Well Abandonment

See Multi-Site FSP, Rev 4, September 8, 2008.

4.5 Groundwater / Surface Water Dynamic Evaluation

No groundwater/surface water (gw/sw) dynamic evaluations are planned as part of the SSWP.

4.5.1 Direct Pore Water Sampling

No groundwater/surface water dynamic evaluations are planned as part of the SSWP.

4.5.2 Indirect Pore Water Samplers

No groundwater/surface water dynamic evaluations are planned as part of the SSWP.

4.5.3 Pore Water Sampling Summary

No groundwater/surface water dynamic evaluations are planned as part of the SSWP.

4.6 Surface Water Monitoring

See Multi-Site FSP, Rev 4, September 8, 2008.

4.7 Sediment Sampling

See Multi-Site FSP, Rev 4, September 8, 2008.

4.8 Soil Vapor Assessment

See Multi-Site FSP, Rev 4, September 8, 2008.

4.9 Field Documentation

See Multi-Site FSP, Rev 4, September 8, 2008.

5 SAMPLE HANDLING

See Multi-Site FSP, Rev 4, September 8, 2008.

5.1 Sample Identification

Soil samples will be identified as follows:

NOS-SB117-001
NOS – North Station Operable Unit
SB117 – Soil boring 117
001 – Primary soil sample from this soil boring

Groundwater samples will be identified as follows:

NOS-MWW101-001
NOS – North Station Operable Unit
MWW101 – Monitoring well-water table well 101
001 – Primary groundwater sample from this monitoring well

NOS-MWP103-001
NOS – North Station Operable Unit
MWP103 – Monitoring well-piezometer 103
001 – Primary groundwater sample from this monitoring well

Soil gas samples will be identified as follows:

NOS-SG001-4'-001
NOS – North Station Operable Unit
SG001 – Soil gas location 001
4' – depth of gas vapor probe at 4'
001 – Primary groundwater sample from this monitoring well

Waste characterization samples will be identified as follows:

NOS-SWC01
NOS – North Station Operable Unit
SWC01 – Soil waste characterization; first sample

Duplicate samples will be identified as follows:

NOS-SB117-101
NOS – North Station Operable Unit
101 – Duplicate sample

Rinsate blank samples will be identified as follows:

NOS-RB01
NOS – North Station Operable Unit
RB01 – Rinsate blank; first sample

Trip blank samples will be identified as follows:

NOS-TB01
NOS – North Station Operable Unit
TB01 – Trip blank; first sample

For additional information see the Multi-Site FSP, Rev 4, September 8, 2008.

5.2 Sample Container, Volume, Preservation and Holding Times

See Multi-Site FSP, Rev 4, September 8, 2008.

5.3 Field Sampling Quality Control

See Multi-Site FSP, Rev 4, September 8, 2008.

5.4 Sample Custody

See Multi-Site FSP, Rev 4, September 8, 2008.

5.5 Sample Shipping

See Multi-Site FSP, Rev 4, September 8, 2008.

6 SAMPLE ANALYSIS

See Multi-Site FSP, Rev 4, September 8, 2008.

7 FIELD SURVEYING

See Multi-Site FSP, Rev 4, September 8, 2008.

8 DECONTAMINATION

See Multi-Site FSP, Rev 4, September 8, 2008.

9 MANAGEMENT OF INVESTIGATION DERIVED WASTES

See Multi-Site FSP, Rev 4, September 8, 2008.

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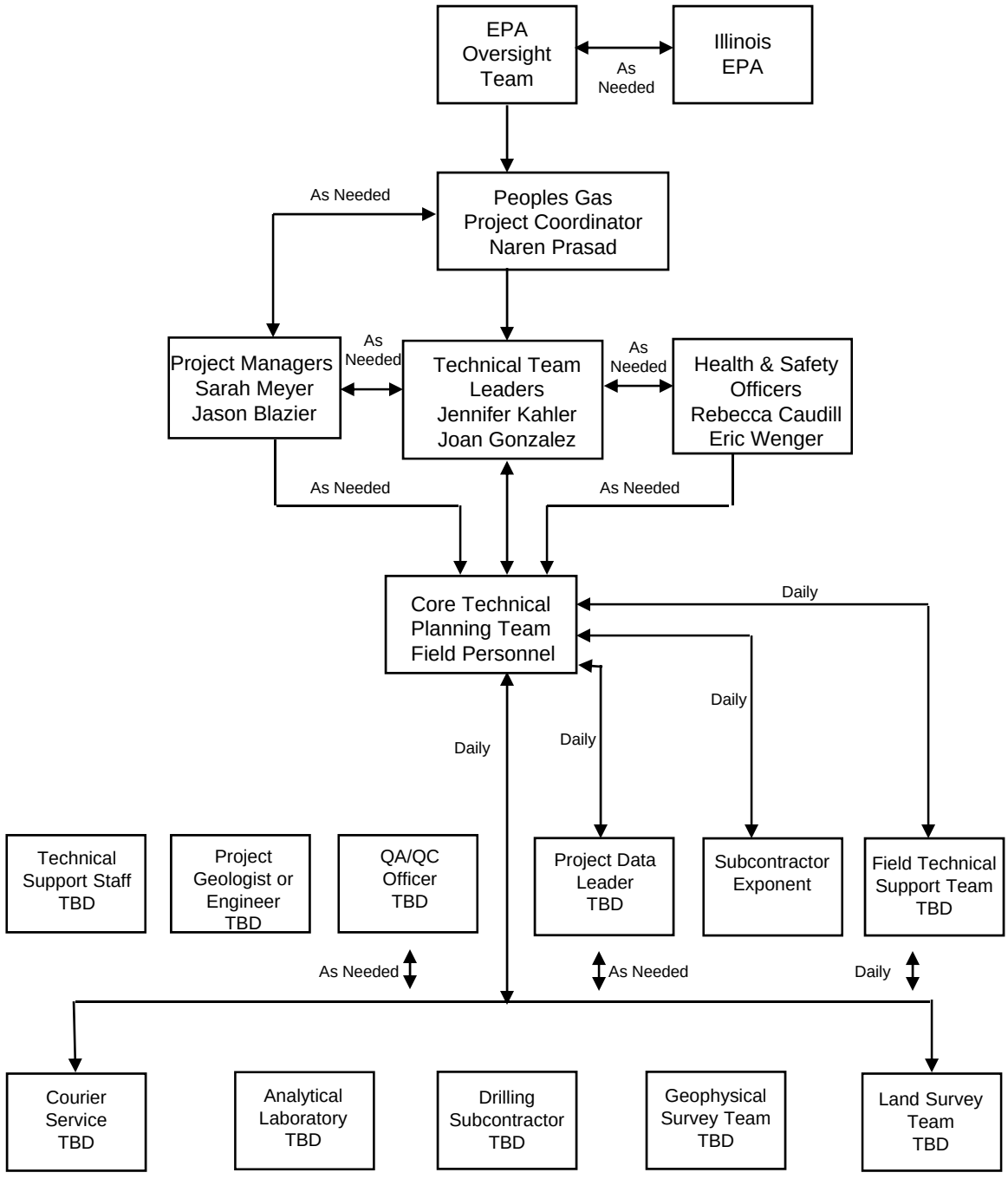
Water-Resources Investigations Report 02-4186. Peter E. Church, Don A. Vroblesky, Forest P. Lyford, and Richard E. Willey.

FIGURES

Appendix B3
Figure 1
Technical Team Strategy



TBD – To Be Determined

ATTACHMENT 1

SURFACE WATER SAMPLING FIELD FORM

Staff Gauge Reading
Time _____ Reading _____ ft

General Information

Site : _____
Project # : _____
Task # : _____
Date : _____
Samplers : _____

Sampling Equipment: _____
Coordinate System: _____
Datum: _____
Weather: _____
River Section/DMU: _____

						Multi Sensor					Turbidity Sensor							
Sample/Location ID	**Time (military)**	**Depth to Sediment**	**Depth to Refusal**	**Penetration Thickness**	**Water Sample Depth**	**Temp (°C)**	**Conductivity (SpC)**	**DO (mg/L)**	**pH**	**ORP**	**Turbidity (NTU)**	**Temp (°C)**	**Depth (ft), x0.2ft, x0.8ft**	**Average Velocity (FPS)**	**Max Velocity (FPS)**	**Sample Location X**	**Sample Location Y**	**Sample Notes**

Notes: (1) Water Elevation = Staff Gauge Elevation - Staff Gauge Reading, Calculated at end of day, based on a minimum of 2 staff gauge readings.

(2) Sample coordinates will be recorded after being post processed, when applicable.

n/a : **Not Applicable**

Additional Comments: _____

POLING FIELD FORM

Staff Gauge Reading
Time _____ Reading _____ ft

General Information

Site : _____
Project # : _____
Task # : _____
Date : _____
Samplers : _____

Sampling Equipment: _____
Coordinate System: _____
Datum: _____
Weather: _____
River Section/DMU: _____

Sample ID	Time (military)	Water Elevation	Depth to Sediment	Depth to Hard Bottom/ Refusal	Poling Thickness / Sample Interval	Sample Location X	Sample Location Y	Sample Description (Color, Texture, Odor)	Sample Notes

Notes: (1) Water Elevation = Staff Gauge Elevation - Staff Gauge Reading, Calculated at end of day, based on a minimum of 2 staff gauge readings

(2) Sample coordinates will be recorded after being post processed, when applicable.

n/a : **Not Applicable**

Sample Collection and Processing Log

Staff Gauge Reading
Time _____ Reading _____ ft

General Information

Project Name/Site : _____ **Sampling Equipment:** _____
Project # : _____ **Coordinate System:** _____
Task # : _____ **Datum:** _____
Date : _____ **Weather:** _____
Samplers : _____ **River Section/DMU:** _____

Sample Location	Time (military)	Water Elevation[1]	Water Depth (ft)	Penetration (ft)	Sediment Recovered (ft)	% Recovery	Sample Location (Northing)[2]	Sample Location (Easting)[2]	Sample Notes

Sample Intervals (in)	Sample Description	Date Processed	Sample Intervals (in) TOP	Sample Intervals (in) BOTTOM	COC Sample ID Number

Additional Comments: _____

Notes: (1) Water Elevation = Staff Gauge Elevation - Staff Gauge Reading, Calculated at end of day, based on a minimum of 2 staff gauge readings.
(2) Sample coordinates will be recorded after being post processed, when applicable.

n/a : **Not Applicable**
COC: Chain of Custody

Sampling/Processing Personnel Signature: _____

APPENDIX B4

SITE-SPECIFIC CSM

B4 SITE-SPECIFIC CONCEPTUAL SITE MODEL AND RISK ASSESSMENT FRAMEWORK

This appendix provides a summary of supplemental methods, approaches, media, receptors (human or ecological) and/or exposure pathways that may be necessary to evaluate the North Station Operable Unit (OU) and were not included in the Final Multi-Site Conceptual Site Model (CSM) and Risk Assessment Framework (RAF). A general Baseline Risk Assessment (BLRA) Report outline is presented in the Multi-Site RAF.

There are two site-specific considerations that may be incorporated into the former North Station OU BLRA depending upon the site conditions encountered during the remedial investigation (RI) or further evaluation, including:

- Evaluation of the potential presence of impacted soil vapor and a completed exposure pathway to human receptors inside on-site buildings; and
- Application of sediment toxicity test data to estimate the sediment risk zone and address potential ecological risks depending upon the outcome of the ambient sediment investigation completed on the North Branch of the Chicago River.

These site-specific considerations are discussed below.

1.1 Additional Potential Receptors and Media Identified in Site Reconnaissance

Soil vapor, related to vapor intrusion (VI) into buildings, is a media of potential concern for buildings on and adjacent to the ComEd Parcel and the LaSalle Chestnut Parcel of the OU. The human health risk assessment methods for this potential exposure pathway are described below.

1.2 Screening Values

The soil and groundwater screening levels (SL) that will be used in the BLRA to address potential human health risks have been updated to rely on the most current United States Environmental Protection Agency (USEPA) Regional Screening Level (RSL) tables (November 2010). The specific soil SLs to be used for residential and industrial/commercial worker exposure scenarios are provided in the Risk Assessment Framework (RAF) Addendum (Exponent April 2011).

VI SLs for soil gas and groundwater have also been updated and are provided in the RAF Addendum (Exponent April 2011). The VI SLs were derived based on the most current indoor air RSLs and default attenuation factors recommended by USEPA (USEPA 2002). The specific VI SLs and methods used to derive the values are presented in the RAF Addendum (Exponent April 2011).

1.3 Supplemental Human Health Risk Assessment Methods

1.3.1 Data Evaluation Process for Vapor Intrusion Assessments

1.3.1.1 Introduction

The purpose of this document is to provide a general framework for evaluating the data obtained during VI assessments. The framework discussed herein represents the current multiple lines of evidence approach for VI assessments which was discussed in a working meeting held on December 17, 2010 between Integrys Business Support, LLC (IBS) and USEPA.

VI assessments will generally include the tiered evaluation of site conditions and data from multiple media to develop multiple line of evidence rather than rely on evaluations of a single line of evidence (e.g., groundwater concentration in comparison to VI SLs). The media that may require evaluation to address the completeness and potential risks associated with the VI exposure pathway include soil (as an indication of source areas for vapors), groundwater, soil gas (i.e., either sub-slab, shallow, and/or deep), and/or indoor air. Data from each medium will be evaluated individually for validity and usability, as well as in combination with data from other media, in order to consider multiple lines of evidence in determining whether VI poses potential

human health risks. The VI evaluation process, as presented in Section 6.7 of the Site-specific Work Plan (SSWP), conceptually follows the tiered approach presented in *United States Environmental Protection Agency (USEPA) Office of Solid Waste and Emergency Response (OSWER) Draft Subsurface Vapor Intrusion Guidance (November 2002)* by proceeding from a generic screening assessment to a site-specific pathway assessment, if necessary. The site-specific evaluation will proceed from Tier 1 toward Tier 3 until the potential for a completed exposure pathway to humans working in the on-site buildings can be eliminated or positively identified:

Tier 1 – Conduct a Tier 1 screening evaluation to determine if VI chemicals of potential concern (VI COPC) are present on site in close proximity to buildings. Part of the Tier 1 VI assessment will include gathering general information such as known or reasonably suspected contaminants present in surface and subsurface media at the OU. This step should also include gathering information about the use and occupancy of the buildings under investigation, whether or not a basement is present.

Tier 2 – Conduct a Tier 2 screening assessment to address if media concentrations are present above VI SLs. This step also includes gathering focused site-specific information such as measured or reasonably estimated concentrations of target contaminants in groundwater or soil vapor, depth of contamination, and soil type. As part of this step, more detailed information on the buildings such as structural details, including building type (construction) and ventilation, presence of sumps, etc., should be collected.

Tier 3 – Conduct a Tier 3, site-specific pathway assessment and gather more detailed site-specific information such as presence of potentially confounding sources of target-contaminant vapor inside the building and results from confirmatory sub-slab or indoor air samples.

While the application of a tiered VI assessment approach has been preserved within the SSWP, the way in which the tiers of evaluations are performed have been modified based on a recent review completed by USEPA of the applicability of the original draft VI guidance published by USEPA in 2002 (USEPA 2002). In 2010, USEPA issued, *Review of the Draft 2002 Subsurface*

Vapor Intrusion Guidance, which provided a summary of expected changes to how the Tiered VI approach is implemented. The key changes based on USEPA's recent review of the 2002 VI guidance that have been incorporated into the VI assessment for North Station OU include:

- Updating of the physical-chemical properties used in the Tier 1 assessment to address if a chemical is sufficiently volatile and should be considered a COPC for purposes of the VI pathway. Those chemicals considered sufficiently volatile were documented in the RAF Addendum.

- The need for updated VI SLs used in Tier 2. The VI SLs (soil gas and groundwater) within the USEPA 2002 guidance are considered out of data and required updating based on more current toxicity and chemistry data. These updated SLs for soil gas and groundwater are presented in the RAF Addendum for VI COPC (Exponent April 2011).

- The need to use a multiple lines of evidence approach for determining the completeness or incompleteness of the VI exposure pathway within Tier 2 and 3 of the VI assessment. USEPA is emphasizing the use of more than one line of evidence to address the completeness of the VI exposure pathway because of the uncertainty inherent in using just one line of evidence. This conclusion has been made based on past experience gained since the 2002 guidance was issued.

In regard this last point, it is particularly important to use multiple lines of evidence as part of the Tier 2 or 3 assessments when a potential source of chemical vapors (soil or groundwater contamination) is located in close proximity (within 35 -100 ft depending upon contaminant type) to a building or located beneath a building structure. In these cases where contamination is present near or under the building, USEPA now prefers soil gas samples to be collected below the building floor (sub-slab soil gas samples) and used with other lines of evidence (e.g., shallow soil gas, deep soil gas and/or groundwater data) outside or beneath the building to evaluate the completeness or incompleteness of the VI exposure pathway. As appropriate, the VI assessment for the North Station OU has been developed to use multiple lines of evidence to address the completeness of the VI exposure pathway for each building of concern at the OU. However, the first step of the VI assessment will still remain the evaluation of whether VI COPCs are present in

close proximity of building structures. If VI COPCs are not located within close proximity of building structure, then the VI exposure pathway will be considered incomplete for that building under current conditions. It should be noted that in areas of the site where VI COPCs are located, but no buildings are currently in close proximity of the contamination, the potential for VI in these areas based on future building construction will be addressed in the Feasibility Study considering appropriate risk management techniques (e.g., institutional controls to prevent the VI pathway from becoming complete). This is intended to indicate to future potential building developers that there may be a potential risk of VI to be considered during building construction, as discussed in the recent USEPA review (USEPA 2010).

Based on some historic site files, it is believed that at least one of the on-site buildings of interest has a basement with sumps. Sumps can act as preferential pathways for contaminant migration and may require special consideration if VI COPC are in close proximity to the buildings with sumps. The USEPA VI SLs are valid only if there are no preferential pathways present that would allow contaminated groundwater or vapors to enter a building, because these preferential pathways may lessen the attenuation of the chemical vapors compared to what was assumed to the develop the VI SLs. Also the primary model (e.g., Johnson and Ettinger spreadsheet) used on a site-specific basis to predict VI assumes the vapors enter the building through cracks in the surrounding floor and walls. If there are preferential pathways, then the spreadsheet model cannot be used, because key model assumptions are not satisfied.

The VI investigation will include characterization of whether a preferential pathway exists for each building (described further later within this section). As appropriate and depending upon if there is preferential pathways (e.g., sumps) or not associated with the building construction, multiple lines of evidence (groundwater data, soil gas data, sump head space samples), will be selected and be used to determine if the VI pathway is complete for each building that is within close proximity to soil or groundwater containing VI COPCs. If the VI exposure pathway is not complete because impacted groundwater or soil vapor is not located near the building footprint (i.e., within the critical distance), then VI will not be considered a concern for that building. A distance of 100 feet from a buildings foundation is being used for impacted soil or groundwater at the North Station OU because chlorinated volatile organic compounds have been detected in site soil and these compounds are less amenable to biodegradation than non-chlorinated compounds.

If contaminated groundwater or soil gas is in close proximity to the building footprint and a sump is present inside the building, then the normal screening approach is not valid (since the sump may serve as a preferential pathway) and cannot be used to evaluate the significance of the groundwater or soil gas contamination adjacent to the building. In this case, a Tier 2 investigation will be conducted which will include collection of soil vapor within the head space of the sump inside the building and soil vapor and/or groundwater outside the building near the sump for evaluation. Concentrations of compounds detected in soil vapor collected in the sump and just above the water table will be compared to indoor air concentrations protective of worker health. The latest RSLs presented in the RAF Addendum for indoor air developed by USEPA for the protection of workers will be used to screen the soil vapor data. The SLs used will be consistent with the toxicity endpoints (cancer or noncancer effects) that will be evaluated in the risk assessment. For example, for ethylbenzene and naphthalene a noncancer endpoint will be used in the risk assessment, and so the noncancer SLs will be used for the vapor evaluation.

If soil vapor screening against the RSLs fails for any chemical, then the VI exposure pathway will be evaluated further. Evaluations that will be considered include:

- Using the soil vapor data as input to an indoor air exposure model to assess if potential risks are negligible or would suggest further sampling is required to assess if the exposure is of potential concern, and
- Proceeding to a Tier 3 investigation that includes indoor air sampling.

The appropriate investigation progression will be selected on a site-specific basis as more information becomes available regarding site conditions during the RI. See Section 6.7 of the SSWP for more detailed information.

1.3.1.2 Medium-specific Evaluation of Analytical Data

Data from different media are appropriate to use for different purposes. For example, many regulatory agencies consider soil data to be inappropriate for evaluating potential exposure due to VI; however, soil data can be very useful to identify locations for groundwater and/or soil vapor sampling. Each environmental medium also has similar benefits and limitations. The following sections discuss the appropriate uses of data from each medium and provide a general description of how the data will be evaluated.

Soil

Limited empirical data are available establishing attenuation factors from soil to indoor air, and modeling VI from soil can be unreliable due to the heterogeneous nature of the medium. As a result of these data limitations, evaluating VI from soil may be less reliable than evaluating VI from other media, such as soil vapor and sub-slab soil vapor. In consideration of these limitations, analytical data from soil will primarily be used as means of identifying locations for collecting soil gas samples. Soil gas samples will be collected from areas where soil sampling has indicated the potential for residual source material to be present.

Groundwater

Groundwater data will primarily be used as a means of identifying soil gas and/or sub-slab soil gas sample locations. Additionally, groundwater data will also be used as one line of evidence to establish whether or not VI poses potential risk at a site. But, as discussed previously groundwater data alone will not be used to address whether the VI exposure pathways is complete, when groundwater containing VI COPC are present within close proximity of a building.

Groundwater VI SLs are defined as risk-based SLs protective of indoor air exposures that are calculated using USEPA recommended attenuation factors from groundwater to indoor air. These SLs are intended to be used in comparison to analytical data from groundwater as a conservative initial evaluation tool. The groundwater VI SLs to be used for the North Station OU are presented in Tables 7 through 12 of the RAF Addendum (Exponent, April 2011). Groundwater data from a well will be compared to VI groundwater SLs to identify areas where soil gas sampling is warranted. These areas may overlap those where residual source material was identified during soil sampling; however, depending on the hydrogeology at a specific site, evaluation of groundwater data in comparison to VI groundwater SLs for the VI pathway may indicate additional locations where soil gas sampling would be prudent.

Groundwater data will also be used in conjunction with soil gas and/or sub-slab data to provide evidence of the presence or absence of a migration pathway from the subsurface to indoor air.

Evaluating analytical data from groundwater along with soil gas data from multiple depth intervals provides a means of tracking the upward vertical migration of vapor-phase chemicals.

Soil Vapor and Sub-slab Soil Vapor

Soil vapor and sub-slab soil vapor will be the primary media used to evaluate whether the VI pathway is complete for a given building under present conditions, and has the potential to pose unacceptable risk to human health. It will also be used to determine if an area could pose a potential VI concern in the future if construction occurred in the area. Collecting soil vapor samples outside the building footprint is less intrusive to building occupants than collecting soil gas samples below the building. For this reason, exterior soil gas sampling will be completed as the first course of investigation, unless it is already known that source material or former MGP structures are located immediately adjacent to or beneath a building. If source material or former MGP structures are located immediately adjacent to or beneath a building, then soil gas samples from within the building will be normally be collected to evaluate the completeness of the VI exposure pathway. However, in some instances, the building footprint and parking lot areas may both be located over the source material such that a soil vapor probe outside the building in the parking lot may mimic the sub-slab soil vapor sample. The ultimate decision of whether to collect exterior or sub-slab soil vapor samples will be influenced by the location of residual source materials. The location of residual source material, the presence of areas of elevated chemical concentrations in groundwater, and building construction and usage information will be factored into the decision of whether soil vapor samples will be collected externally to the building or sub-slab within the building.

The USEPA has compiled empirical data on attenuation factors from soil vapor and sub-slab soil vapor to indoor air, and has recommend specific attenuations for use in developing soil gas SLs. The attenuation factors agreed to be used to develop the soil gas SLs are provided in the RAF Addendum (Exponent, April 2011). The soil gas SLs are defined as risk-based SLs protective of indoor air exposures. These soil gas SLs are intended to be used in comparison to analytical data from soil gas (i.e., sub-slab/shallow or deep sampling locations) as a conservative initial evaluation tool. When collecting soil gas samples, fixed gases (i.e., oxygen, carbon dioxide, and methane) will be included in the analytical suite. Data on fixed gases can be used to evaluate the

potential for bioattenuation, which can then be used with the site-specific soil gas results to explain qualitatively the site-specific level of attenuation observed. Soil vapor data will be compared to the applicable soil gas SLs to determine whether additional evaluation or mitigation is warranted. If exterior soil vapor data exceed soil gas SLs within close proximity to a building, consideration will be given to whether sub-slab soil gas samples need to be collected, considering the factors previously described. If sub-slab soil gas data are collected and also exceed soil gas SLs, consideration will be given to either collecting indoor air samples or taking mitigation measures.

Indoor Air

This VI program is designed with the intent of performing indoor air sampling only when it is considered necessary to put into perspective the significance of COPC concentrations in soil gas that exceed the SLs at locations measured below the building. Many of the COPCs at former MGP sites are also commonly present in household and commercial products, and the likely presence of indoor sources of site-related compounds confounds interpretation of the resulting analytical data. However, should indoor air sampling be warranted, the resulting data will be used in conjunction with soil vapor, sub-slab vapor, outdoor (ambient) air, and/or groundwater data to establish the presence or absence of a completed VI pathway. If it is concluded that COPCs in indoor air are likely present as a result of VI, the indoor air data will be used to evaluate potential risks to human health. Risks to human health will either be evaluated by comparing the indoor air analytical data to the risk-based indoor SLs for indoor air presented in the RAF addendum for residential and commercial/industrial occupancy, or by completing a site-specific risk assessment that is tailored to the specific building characteristics and populations using the building.

1.3.1.3 References

USEPA, 2002, *United States Environmental Protection Agency (USEPA) Office of Solid Waste and Emergency Response (OSWER) Draft Subsurface Vapor Intrusion Guidance, EPA 530-D-02-004.*

USEPA, 2010, *United States Environmental Protection Agency (USEPA) Office of Solid Waste and Emergency Response (OSWER). Review of the Draft 2002 Subsurface Vapor Intrusion Guidance.*

1.4 Supplemental Ecological Risk Assessment Methods

There are no additional risk assessment methods necessary to evaluate ecological receptors and media to be considered at the North Station OU beyond those presented in the Multi-Site CSM (IBS 2007) and RAF (Exponent 2007. However, the need for sediment toxicity testing as a risk assessment method for the North Station OU will be evaluated largely on the results of the ambient sediment investigation conducted on the North Branch of the Chicago River in 2011. The possible outcomes of the ambient sediment investigation and utility of toxicity testing in the North Branch environment were discussed in Appendix D of the Division Street SSWP, Revision 1 (IBS 2009).

The results of the ambient investigation are currently being evaluated by IBS. Based on the results of the ambient investigation, it is clear that there are high concentrations of polycyclic aromatic hydrocarbons (PAH) and metals in the ambient reach of the North Branch of the Chicago River. The elevated concentrations of PAHs and metals in ambient sediments will be considered along with the Step 1 sediment investigation results to determine if sediment toxicity testing will be necessary and useful as part of the Step 2 sediment investigation at the North Station OU.

APPENDIX C

CHARACTERIZATION OF AMBIENT CONDITIONS IN THE CHICAGO RIVER UPSTREAM OF THE NORTH BRANCH SITE
(INCLUDED ON CD)

Exponent®

Characterization of Ambient Conditions in the Chicago River Upstream from the North Branch MGP Sites

Exponent®

Characterization of Ambient Conditions in the Chicago River Upstream from the North Branch MGP Sites

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1 Background and Objectives

The term "ambient sediments" is used within the context of a site assessment to indicate those sediments present in the river system that are not influenced by conditions related to the specific site under investigation. By convention, these sediments are usually identified as the sediments located upstream or otherwise out of the potential influence of a site or sites. Characterizing ambient sediments is important because it provides the basis for identifying conditions that are influenced by the site. This document presents the approach to characterize ambient sediment conditions upstream from the former manufactured gas plants (MGPs) at the Division Street, Hawthorne Avenue, Willow Street, and North Station sites (the North Branch MGP sites). This approach will also be applied, as appropriate, to the North Shore Avenue Station MGP site (located upstream of these North Branch MGP sites) as well as the South Branch MGP sites (22nd Street, Throop Street, South, Hough Place, and Pitney Court Stations) and the Crawford Station Site at a later stage. Figure 1 presents the MGP site locations. The North Shore Avenue Site is located many miles upstream of the North Branch MGP sites and thus is not expected to impact the Chicago River near the North Branch MGP sites. MGP sites usually only have a localized affect on sediment quality within a riverine environment. Therefore, ambient characterization at each spatially distinct site (North Shore Avenue Station MGP site) or group of sites (North Branch MGP sites and South Branch MGP sites), will be performed separately.

The concentrations and composition of polycyclic aromatic hydrocarbons (PAHs) are considered the most important aspect of defining ambient, as these compounds tend to be the ones that contribute to the risks associated with sediments adjacent to former MGPs. Metals and select other compounds will also be characterized.

The importance of considering ambient sediment conditions was highlighted in the multi-site risk assessment framework (RAF) document used as the risk assessment guide at these MGP sites (Exponent 2007). Because the Chicago River has a long history of urban and industrial development, the sediments are expected to reflect historical inputs, and there is the probability that some ambient sediments will be toxic to benthic invertebrates based on these inputs. For these reasons, the approach used to define ambient conditions must consider these possibilities

and be sufficiently robust to identify departures from ambient conditions that are site-related. Thus, characterizing the ambient sediment quality upstream from the former MGP sites will provide the necessary data to determine the extent of MGP-related contamination to the river and the increased risk caused by this contamination, if any. The objectives for the ambient sediment characterization include:

- Characterize the ambient chemical composition to distinguish MGP impacts from ambient impacts
- Characterize whether the ambient sediments have the potential to support benthic invertebrates.

The objective for chemical characterization of ambient conditions of the Chicago River was to be able to provide a distinction between MGP-related chemical concentrations and ambient concentrations. A stratified random sediment sampling design was used to select sampling stations within an "ambient zone" of the Chicago River upstream of the North Branch MGP sites. Twenty surface sediment samples will be collected to assess ambient conditions within the river. These 20 ambient surface sediment samples will be collected in areas located upstream from the North Branch MGP sites and also away from other potential industrial sources (i.e., either historical or current) of PAH contamination to the River. In addition to samples that will be used to characterize ambient conditions, five or more additional sediment samples will be collected near potential upstream sources of PAHs. These sources would include major stormwater outfalls and locations immediately adjacent to industrial sites known to make use of coal-tar or petroleum-based products. The samples from these potential source areas will be archived (stored frozen at −20°C) and analyzed for PAHs and metals as necessary to help resolve confounding factors that may arise in the assessment of ambient conditions. The frozen samples will not be used for toxicity testing. Based on an EPA report titled, *Sample Holding Time Reevaluation*, dated November 2005 freezing at −20°C will preserve the PAHs in sediment samples (U.S. EPA. 2005).

The characterization of ambient conditions will focus on surface sediments, operationally defined as the upper 6 in. However, there may be a need to understand historical ambient

conditions. For this reason, a subset of five of the ambient sample locations will also be vertically profiled to assess the chemical distribution in the sediment with depth. These deeper samples will be archived (stored frozen) in the event such information is needed in the future.

As noted, ambient surface samples will be analyzed while source area samples and samples collected at depth will be archived (frozen) and analyzed for PAHs and metals only if MGP site-specific conditions require further evaluation to explain differences between ambient conditions and samples collected in the immediate vicinity of a MGP site. Chemical characterization of ambient sediment samples will include analysis for constituents related to former MGP activities, including PAHs, petroleum volatile organic compounds (PVOCs), phenols, metals, and cyanide. The list of chemical constituents is provided in Table 1 of the RAF. In addition to the chemical constituents, sediments will be analyzed for grain size and total organic carbon (TOC). Chemical concentrations in ambient sediment samples will be used to characterize the mean, range, and upper limit (e.g., upper tolerance limit [UTL]) of concentrations representative of ambient conditions unrelated to former MGP activities. The chemical analyses will also include chemical fingerprinting to help differentiate between PAHs in ambient areas and those associated with the North Branch MGP sites.

Because of the history of industrial and urban activity along the Chicago River, the ambient sediments could exhibit some toxicity to benthic invertebrates, and because toxicity measurements and predictions are used to evaluate the risks associated with exposure to sediments influenced by MGPs, the presence of toxicity in the ambient locations could be a confounding factor. Therefore, it is important to evaluate the level of toxicity that may be present in the ambient samples. This information can be used in various ways, as described in the work plan. However, one of the following outcomes and associated assessment decisions is anticipated:

1. The ambient sediments do not exhibit significant toxicity compared to the control samples used in the laboratory. This outcome indicates that toxicity tests will be useful for determining whether the North Branch MGP sites are contributing to toxicity, and that sediment samples collected off MGP sites

can be evaluated by comparing them with both the ambient samples and laboratory controls.

2. The ambient sediments exhibit some toxicity and many of the samples may be significantly different from the laboratory control samples. This outcome indicates that there is some level of toxicity associated with ambient conditions and that level of toxicity needs to be factored into the evaluation of toxicity for sediments at the MGP site. The information can also be used to determine the test sample size needed to detect a specified degree of increasing toxicity (e.g., 20 percent) for sediments potentially influenced by the MGP.

3. The ambient sediments exhibit substantial toxicity and it would be difficult to detect incremental increases in toxicity. This outcome suggests that toxicity testing at downstream sites may not be able to detect an added influence associated with the MGP. With this outcome, the need to conduct toxicity testing should be re-evaluated, because the testing may provide little value.

It is anticipated that Outcome 2 is most likely followed by Outcome 1. Outcome 3 is a possibility.

2 Ambient and Source Specific Sampling

2.1 Selection of the Chicago River Segment for Ambient Sampling

Ambient sediment conditions will be defined within a 1.3-mile segment (approximately) of the Chicago River upstream from the North Branch MGP sites (Figure 2). This segment is not affected by the former MGP sites, but has been influenced by the general urban Chicago environment and would best represent the ambient conditions near the sites.

2.2 Selection of Potential Sample Locations within the Ambient Segment

In order to have a randomized basis for selecting the 20 ambient samples, the ambient zone was partitioned into twenty-one 100-m long reaches with four polygons per reach (i.e., 84 polygons). Within each 100-m reach, there were 4polygons equivalent to approximately one-quarter of the river width and 100 m long were located (Figure 2); thus, ambient samples will potentially be collected over a 2,100-m segment of the river. The four sample polygons within each 100-m reach include two near shore samples and two main channel samples. A total of 10 near shore and 10 main channel samples will be collected. The two zones (near shore and main channel) will be compared to one another to evaluate if there is any difference in ambient concentrations between these two zones. A potential sediment sample location was randomly placed within each polygon so that sampling would not be biased within the polygon if it were used to characterize ambient conditions. It is recognized that within each reach there may be influences from specific urban areas sources (e.g., major stormwater outfalls, facilities using coal-tar or petroleum-based materials). These polygons, influenced by obvious and known apparent PAH sources, *will not* be selected for the ambient sampling, but rather will be considered for collecting samples for possible future characterization of sources.

In addition to the 20 ambient samples, a minimum of 5 source area surface sediment samples will be collected at locations where PAH sources are suspected. These samples will be archived (frozen). These source samples will not be randomly located within the polygon, but will be located close to apparent PAH sources to maximize the chemical "signal" associated with the source. The purpose of these source samples is to define the chemical fingerprints of PAHs sources affecting this stretch of the Chicago River as well as the relationship between these sources and overall ambient conditions. Potential source areas based on historical information (e.g., review of Sanborn fire insurance maps) or based on current knowledge of land use are shown on Figure 3. There has been diverse historical commercial/industrial use of the properties adjacent to the Chicago River either within the proposed ambient zone or between the ambient zone and the Division Street Station site (Figure 3). The land uses include:

- Metal forging and fabrication
- Bulk storage of petroleum products
- Chemical manufacturing of soaps, paints and varnishes, and pesticides
- Tanneries
- Scrap yards
- Coal storage
- Ship yards
- Asphalt pavement manufacturing.

Of the historical commercial/industrial uses listed above, asphalt pavement manufacturing and bulk storage of petroleum products are the land uses that have the greatest potential to have contributed PAHs to the river. For this reason, when sampling in the ambient zone these areas will be treated as potential source areas. It is assumed that storm sewer outfalls were discharge points where contaminants from these sources and general urban street runoff may have entered the river. Therefore, source area surface sediment samples will be collected where storm sewer outfalls are located that correspond to a potential PAH source to characterize potential

contamination. Outfalls will be mapped as an initial field effort because the number and location with respect to potential source areas is not known. Once the outfalls are mapped and reviewed in relation to the potential source areas shown on Figure 3, a minimum of five specific source area sample locations will be selected. Based on the spatial distribution of the outfalls and the location of selected source area samples, the ambient sample locations will be determined to provide for good spatial representation of the ambient zone. The number of ambient samples collected from a 100-m reach (i.e., 2 samples or all 4 samples) will be determined after the source area samples are identified in the field. Two possible sampling schemes will be considered. Examples of each sampling scheme are included in Table 1.

Sampling Scheme 1—Sampling all four potential ambient sediment samples from a given 100-m reach (i.e., left bank, left main channel, right main channel, and right bank samples).

Sampling Scheme 2—Alternatively sampling every other ambient sediment sample within a reach (i.e., left bank and right main channel samples collected from a reach followed by the right bank and left channel sample from the next upstream reach).

In both schemes, the samples would be numbered consistently across the channel (1, 2, 3, 4). In the latter sampling scheme, samples 1 (left bank) and 3 (right channel) would be sampled in a reach and then in the next upstream reach sample 2 (left channel) and 4 right bank) would be collected. This would allow for a bank and main channel sample to be collected within each reach, and would provide an equal representation of the left and right banks and main channel as the sampling progresses upstream.

If many source areas of PAHs are identified during the initial mapping of source areas, then sampling scheme 1 would be more advantageous in providing the spatial scale that is desired. The intent of the ambient sampling design is to avoid source areas within the ambient area when collecting the ambient sediment samples. Sampling scheme 1 is the preferred scheme and sampling scheme 2 would be used only if source areas within the ambient area are too numerous to make sampling scheme 1 feasible. Note that a limited number of source area sediment samples will collected in the ambient area and archived for possible forensic analyses, but the primary goal of the ambient characterization is not to sample source areas. The source areas

samples in the ambient area will only be used if it is necessary to distinguish between source area contaminations from MGP sources in the investigative area from contamination originating from sources areas in the ambient area.

Sample locations will be refined after an initial field reconnaissance. Once the sample locations are initially selected based on the reconnaissance, the proposed sample locations will be provided to the U.S. Environmental Protection Agency (EPA) for review and comment. The final selection of sample locations incorporating EPA feedback will be provided to EPA prior to collecting the sediment samples.

3 Chemical Characterization of Ambient Conditions

This section describes the strategy that will be used to characterize ambient chemical conditions upstream of the North Branch MGP sites. Chemical characterization will focus on the origin and distribution of individual PAHs in sediments, as this will be the strongest line of evidence to distinguish MGP-related impacts from the impacts of PAHs resulting from other sources. Other chemicals of potential concern (CoPCs) associated with North Branch MGP sites (Table 1 of the RAF) will also be considered because of the historical industrial land use along the Chicago River.

3.1 Number of Ambient and Source-Specific Samples

A minimum of twenty-five sediment samples will be collected to evaluate ambient and source conditions at the site, they will be distributed as follows:

- Twenty sediment samples will be collected within reaches *not* located near identified PAH sources
- A minimum of five sediment samples will be collected within reaches *potentially influenced* by historical or current PAH sources (e.g., outfalls). The objective is to collect samples from a minimum of five reaches containing stormwater outfalls where source areas were historically present.

A surface sediment sample consisting of the top 6 in. (0−0.5 ft) will be collected at each location (i.e., ambient or source area). The 20 ambient surface sediment samples will be distributed evenly among the polygons within the reaches that are identified to be outside of source areas. As described previously, depending on the spatial distribution of the potential ambient samples, the number of samples collected from a 100-m reach (i.e., 2 sample or all 4 samples) will be determined after the source areas are identified in the field.

In addition to the surface samples, at every fourth ambient surface sample station, a core will be collected to vertically define the chemical characteristics of the sediments (total of five cores). Each sediment core will be subdivided into discrete 1-ft depth intervals that mirror the sampling strategy used for the site-specific MGP site sediment investigations. The end depth of the vertical profile will be limited to the thickness of the soft-sediment layer at the sample location. Sediment sampling will start north of the Willow/Hawthorne stations and proceed upstream until all 20 ambient and 5 source area sediment samples are collected.

All of the ambient surface sediment samples (i.e., 20 total) will be analyzed for an expanded list of PAHs (including alkylated PAHs), PVOCs, phenols, metals, and cyanide. In addition to these chemical constituents, the sediments will be analyzed for grain size and TOC. The source area sediment samples and subsurface sediment samples will be archived (frozen) and analyzed for PAHs and metals only if necessary based on site-specific chemical results.

The 20 samples were selected to provide a statistically accurate estimate of the mean and UTL of ambient chemical concentrations. In addition, this number of samples provides a reasonable database for meaningful comparisons of the PAH fingerprinting results. Additional ambient sampling will be considered to supplement what has been proposed herein if it is determined that the data set is not robust enough to meet the project data quality objectives based on the variability of the sediment analytical results. However, until the initial data are collected and evaluated, the need for additional sampling remains unclear.

3.2 Analytical Requirements

Surface sediment samples will be analyzed for an expanded list of PAHs (including alkylated PAHs) using EPA's Method 8270 (gas chromatography/mass spectrometry), a standard practice for PAH chemical fingerprinting. The samples will also be analyzed for PVOCs, metals, and cyanide as listed in Table 1 of the RAF. In addition to the chemical constituents, the sediments will be analyzed for grain size and TOC. These analyses will be performed according to the methods listed in the site-specific quality assurance project plan for the site. These analytical data will be used to define the ambient conditions of the Chicago River upstream from the

former MGP sites and for comparison with PAH, PVOC, phenol, metal, and cyanide results from the former MGP sites.

Archived source and subsurface sediment samples will be frozen at −20°C and analyzed only for the expanded list of PAHs and metals defined in Table 1 of the RAF. The main purpose for these archived samples is to help evaluate the potential source of the constituents.

3.3 Data Analysis

The data for the ambient samples and the source areas samples will be analyzed separately to provide statistics for each of these groups of samples. EPA's most current version of the ProUCL statistical software package will be used to calculate summary statistics and develop an estimate of the mean and 95th UTL (i.e., 95th percentile with 95 percent coverage). This statistical package is designed to test the underlying distribution of the data (e.g., normal, log-normal, gamma, or other). Where a defined underlying data distribution cannot be defined, the program allows for a number of nonparametric methods to estimate the UTL. The UTL will be used for sample-by-sample comparison of total PAH concentrations (or any other CoPCs) with the investigative data. The investigative sediment samples will be defined as those sediment samples collected adjacent to or downstream of the former Division Street MGP, excluding the upstream transect samples, which will be considered ambient sediment samples. The investigative sample set is estimated to include up to 40 sediment sampling locations adjacent to or downstream of the former Division Street MGP. Samples collected in the investigative areas below the UTL will be considered to be within ambient conditions.

The "sample-by-sample" comparisons described above will be between the 95th upper tolerance limit on the 95th percentile (95% UTL) calculated from the ambient sample data set (excluding all source samples) and each investigative sample location concentration. An upper tolerance limit is by definition a one-sided upper limit on the selected percentile (i.e., 95th percentile in this case) similar in nature to the upper confidence limit (UCL) on the mean. The 95 % UTL for total PAHs developed based on the ambient data set will be used to gauge which areas within the investigative area are affected by past MGP activities, and which areas are comparable to ambient conditions.

This approach is used as a screening tool to distinguish site-related impacts from ambient conditions. Other forensic techniques described below will be used as needed to distinguish ambient PAHs from MGP related PAHs.

Comparison of individual sample concentrations with the 95% UTL will liberally identify locations with concentrations above ambient conditions that may be masked by comparing the mean concentrations. However for some analytes (metals for example) where there may not be site-related impacts, the comparison of means (using a one-tailed test) will be performed to control for the overall false positive error rate that may occur using the UTL approach. The 95% UTL comparisons will still be used to identify specific sediment sample locations exceeding ambient conditions for a specific metal when the site mean metal concentration is significantly higher than the ambient mean metal concentration. PAHs attributable to ambient conditions may be differentiated from the MGP PAHs through the application of chemical fingerprinting techniques including:

- **PAH Profile Comparisons—**The characteristic PAH compositional profile of the ambient samples will be compared with the apparent non-MGP sources, and compared with MGP source samples (i.e., tar) to determine the extent of the MGP impacts to the river.

- **Diagnostic PAH Source Ratio (the concentration of one PAH compound relative to another)—**These methods have been used for identifying the sources of PAH contaminants in sediments. For example, ratios such as phenanthrene/anthracene (P/A) and fluoranthene/pyrene (FL/PY) have been used to differentiate between pyrogenic PAH sources (Boehm 2006). These ratios are used as input to perform statistical analysis of the data (described below).

- **Statistical Tools Including Principal Component Analysis—**Principal component analysis is the primary statistical tool used to condense a complex set of variables used to fingerprint a sample—the relative PAH compound concentrations in every sediment sample—down to a series of surrogate factors that explain much of the variability in the data set.

4 Biological Characterization of Ambient Conditions

A second object of the ambient sediment sampling is to characterize whether sediment in the Chicago River can support benthic invertebrates (e.g., caddis, mayflies, and true flies). As specified in the multi-site RAF document, sediment toxicity testing may be incorporated on a site-specific basis to evaluate the zones of risk within the aquatic environment based on toxicity to benthic invertebrates. Because these benthic invertebrates live the majority of their life cycle in the surface sediments (generally top 6 in. or less), they are at most risk to MGP-related constituents in the sediment. However, in the case of the Chicago River, it is possible that the ambient river conditions impose enough stress on the benthic invertebrates, that ambient conditions may be toxic to the test organisms. For this reason, as part of the ambient conditions characterization, the toxicity of the surface sediments will be evaluated.

A portion of 10 ambient surface sediment samples will be tested for toxicity using the 21-day *Hyalella azteca* toxicity test specified in the multi-site RAF. The 10 samples will be distributed evenly throughout the portion of the ambient zone that is ultimately sampled. It is envisioned that sediment from every other ambient surface sediment sample station will be submitted for toxicity testing. Thus, a total of five near shore and five main channel samples will be evaluated. This toxicity test includes an evaluation of organism survival and growth. Ten samples are considered sufficient to provide a clear indication of whether the ambient zone sediments are or are not toxic to the organisms. However, depending on the results of these initial 10 samples, it may be determined that further ambient sampling will be required to evaluate the utility of the toxicity testing if the sample results are in a gray zone (i.e., not clearly toxic or nontoxic). Surface sediments will be used for biological testing because this is the layer where conditions are normally suitable for the organism to live (e.g., oxygen concentrations are sufficient). The range of response in the 10 samples will be evaluated to determine whether the toxicity data indicate that there are consistent conditions present in the ambient area that are either supportive of or detrimental to organism growth and survival. This information will be used to evaluate whether toxicity testing will be a helpful to define areas of potential ecological risk at the specific North Branch MGP sites. If, for example, ambient samples show little toxicity to the organisms, then toxicity testing would clearly be a useful line of evidence in the

ecological risk assessment. If on the other hand, the ambient sediments are consistently toxic to the organism, then conducting toxicity testing would not help to define incremental levels of risk associated with MGP-related chemicals. The sediment toxicity data collected for the ambient zone will be taken into account when evaluating the sediment toxicity data for the individual North Branch MGP site investigations.

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APPENDIX D

SITE-SPECIFIC COPC SCREEN FOR SOIL, GROUNDWATER, SEDIMENT AND SURFACE WATER

Appendix D

Site-Specific COPC Screen for Soil, Groundwater, Sediment and Surface Water at the North Station Operable Unit Former MGP Site

Constituents of potential concern (COPC) at former MGP sites within the Integrys Multi-Site program can be found in Table 1 of the USEPA-approved Multi-Site Risk Assessment Framework (RAF) (Attachment D-1). A supplemental screening assessment has been performed for the North Station Operable Unit (OU), to address USEPA concerns regarding the potential presence of additional constituents that are not included in Table 1 of the RAF. This supplemental screening has been performed to determine if additional constituents should be added to those on the Multi-Site RAF COPC list, based on a site-specific assessment which considers the results of previous on-site sampling and historic property uses.

This supplemental assessment was performed using historic data and the following screening techniques:

- Maximum constituent concentrations were compared to residential screening levels (SL) using the sources and hierarchy described in the Multi-Site document, *Draft Risk Assessment Framework Addendum* (Exponent 2011). Those constituents with maximum concentrations above the residential SL were carried forward for further consideration as site-specific COPCs;
- The frequency of detection above the method detection limit (MDL) was determined for those chemicals that exceeded residential SLs to assess their prevalence on site. Analytes detected above the residential SLs that were also detected above MDLs in more than 5 percent (%) of the samples analyzed would be carried forward as site-specific COPCs. The 5 % criterion is a common supplemental criterion used in COPC selection within risk assessments (USEPA 1989); and,
- Constituents that exceeded the residential SL with a frequency of detection above the MDL of less than 5% were not carried forward as potential COPCs unless a site-specific factor indicated that further evaluation was prudent. This criterion is only applied on portions of the North Station OU where soils have been well characterized and is not used in other areas of the OU for soil or groundwater where limited previous sampling has been completed.

The results of this site-specific COPC screening process are described below for each matrix.

Supplemental Site-Specific Soil COPC Evaluation

ComEd, LaSalle Chestnut, Division-Halsted, and City Right-of-Way Parcels

Extensive soil investigation has been completed for the ComEd, LaSalle Chestnut, Division-Halsted, and City Right-of-Way parcels. These parcels are assessed collectively because they encompass what was the former MGP facility and property. In addition, the City right-of-ways are immediately adjacent to and surround the former MGP operations which occurred on the ComEd Parcel. MGP residuals have been detected at numerous locations on these City right-of-ways.

Summary statistics for constituents that exceed residential SLs in soil on these parcels are presented in Appendix D, Table D-1. Analytes that did not exceed their respective residential SL are not listed in the table.

One constituent, 3,3-dichlorobenzidine, was detected above the residential SL in one soil sample. However, its frequency of detection was less than 5% and, for that reason, it is not considered a site-specific COPC.

The soil constituents that exceed the residential SLs and also have a frequency of detection above MDLs greater than 5% at the North Station OU include the following:

- Volatile organic compounds (VOC) – benzene and total xylenes;
- Semivolatile organic compounds (SVOC) – 2-methylnaphthalene and dibenzofuran
- Polycyclic aromatic hydrocarbons (PAH) - benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, naphthalene, and pyrene;
- Metals – total arsenic and total lead.

These constituents will be analyzed in soil samples collected at the ComEd, LaSalle Chestnut, Division-Halsted, and City Right-of-Way parcels. In addition, all petroleum VOCs (PVOC) and PAHs from the Multi-Site RAF COPC list will be retained as site-specific COPCs because they are typically the main risk drivers at MGP sites.

The ComEd Parcel is currently used as an electric power substation and although extensive site characterization has been completed, polychlorinated biphenyls (PCB) have only been analyzed in one soil sample collected on the facility parcels. Because the ComEd parcel is an electric power substation, and the operation of the station may have included the use of fluids containing PCBs at some time in the past, PCBs will also be added to the site-specific COPC list.

Chlorinated ethenes and ethanes have been sampled on these parcels in the past. Of the 207 samples that were analyzed for chlorinated compounds, two samples contained chlorinated 1,1,1-trichloroethane and/or 1,1,2,2-tetrachloroethane at concentrations above the MDL but below the residential SL. Therefore, chlorinated compounds will be not carried forward as COPCs.

For the remaining parcels included in the proposed RI work, the COPC selection process for soil will consider the following:

- Property use history at the Halsted Parcel was not related to the MGP. Use of this parcel included coal storage, a service station with three gasoline underground storage tanks (UST), and a warehouse with suspected fuel oil and gasoline USTs.
- Property use history at the Division Parcel was not related to the MGP. Use of this parcel included coal and oil storage.

The proposed COPCs for these parcels are discussed below.

Old Town Village West Parcel

The Old Town Village West parcel has not yet been sampled or investigated by PGL and has a property-use history that includes a lumber yard, automobile maintenance/repair garages, junkyard, metal and die cutting shop, sign factory and various manufacturing facilities and factories. In addition, liquid in a underground storage tank (UST) formerly located at the corner of Elm and Crosby Streets (UST #1) contained an unknown liquid with 4.5 parts per million PCBs (Harding Lawson Assoc., 1996). Because it has not yet been substantially investigated, the Old Town Village West parcel will be analyzed for the full Multi-Site RAF COPC list; because of the historic property use, which may have included the use of fuels, solvents and oils, and PCB-containing liquids, soil on this parcel will be analyzed for an expanded list of VOCs (Target Compound List [TCL]) and PCBs.

Halsted Parcel

The Halsted Parcel is located immediately west of the former MGP operations on the ComEd Parcel and has been the subject of two site investigations related to property ownership transfers. As noted above, the historic property use included storage of coal, gasoline USTs and a fuel oil UST (Sanborn map, 1935). MGP residuals were found on the ComEd Parcel and along Kingsbury Street, adjacent to the Halsted Parcel. Soil samples collected on Halsted Parcel will be analyzed for the full multi-site RAF COPC list and PCBs.

Division Parcel

The Division Parcel is located immediately north of the ComEd Parcel and has not yet been sampled or investigated. The historic property use included storage of coal and oil (Sanborn map, 1910). MGP residuals were found on the ComEd Parcel adjacent to the Division Parcel. Because it has not yet been investigated and is not located on the former MGP property, soil samples collected on the Division Parcel will be analyzed for the full multi-site RAF COPC list and PCBs.

A summary of site-specific soil COPCs for the North Station OU is presented in Appendix D, Table D-2.

Site-Specific Groundwater COPC Evaluation

A sufficiently large groundwater data set does not currently exist to enable performing a site-specific COPC evaluation similar to soils. Eighteen monitoring wells, including six temporary wells, were installed and sampled one time each. Several wells have been destroyed during the LaSalle-Chestnut site remediation and the status of any remaining wells is unknown. No groundwater samples have been collected since 2005. Based on what is known about site soils and groundwater, the proposed site-specific COPCs for groundwater will include:

- The North Station OU site-specific COPC list developed for soils; and,
- Groundwater constituents previously sampled on the ComEd, LaSalle Chestnut, and Division-Halsted parcels that exceeded the residential SL for water and are not included in the North Station OU site-specific COPC list for soils (total antimony, total manganese, available cyanide, phenol and styrene).

Bis(2-ethylhexyl)phthalate was detected in one sample slightly above the MDL. It is not included in the groundwater COPC list above because it is a common laboratory contaminant (USEPA, 1992). A summary of site-specific groundwater COPCs for the North Station OU is presented in Appendix D, Table D-2.

The groundwater COPC list will be re-evaluated based on results from proposed soil and groundwater sampling. Historic and new soil sampling results will be re-evaluated for COPCs as above, and groundwater COPCs will be modified to incorporate changes to the soil COPCs. In addition, groundwater sampling events beyond the first two rounds of analytical results will be evaluated to determine if the groundwater COPC list can be modified through the Multi-Site Conceptual Site Model (CSM) process. If an analyte does not exceed the residential SL for two rounds of groundwater sampling, it will be removed from the site-specific COPC list.

Site-Specific Sediment and Surface Water COPC Selection

For sediment and surface water, the constituents listed in the Multi-Site RAF COPC list will be carried forward as site-specific COPCs. Based on the results of the ambient sediment investigation, the site-specific sediment COPC list may be modified in a manner mutually agreed-upon with USEPA.

A summary of site-specific sediment and surface water COPCs for the North Station OU is presented in Appendix D, Table D-2.

References

Exponent, March 2011. “Draft Risk Assessment Framework Addendum.”

Harding Lawson Associates, June 14, 1986. “Catch Basin/Machine Pit Cleaning and UST Removal, Former Spanjer Brothers Site, Southeast Corner of West Division and North Crosby Street, Chicago, Illinois.”

USEPA, 1989. “Risk assessment guidance for Superfund—Volume I: Human Health Evaluation Manual (Part A),” Interim final. EPA/540/1-89/002. Office of Solid Waste and Remedial Response, Washington, DC.

USEPA, 1992. “Guidance for Data Useability in Risk Assessment (Part A),” Final Publication 9285.7-09A PB92-963356. Office of Emergency and Remedial Response, Washington, DC. Appendix VII Summary of Common Laboratory Contaminants

Sanborn Library, LLC, 1910 & 1935. Certified Sanborn Map

Attachments:

Attachment D-1 Table 1 of the USEPA-Approved Multi-Site Risk Assessment Framework (RAF) - MGP-Related Contaminants of Potential Concern, Former MGP Sites, EPA Region 5

Tables Table D-1 – Summary Statistics for Soils on the ComEd and City Right-of-Way Parcels

Table D-2 – Site-Specific COPCs for Soil, Groundwater, Sediment and Surface Water

Attachment D-1

Table 1 of the USEPA-Approved Multi-Site Risk Assessment Framework

MGP-Related Contaminants of Potential Concern

Former MGP sites, EPA Region 5

Table 1. MGP-related contaminants of potential concern, former MGP sites, EPA Region 5

PAHs	PVOCs	Inorganic Compounds	Acid Extractable Organic Compounds
Naphthalene	Benzene	Aluminum	2,4-Dimethylphenol
C1-Naphthalenes[a]	Ethylbenzene	Antimony	2-Methylphenol
C2-Naphthalenes[a]	Toluene	Arsenic	4-Methylphenol
C3-Naphthalenes[a]	Xylenes (Total)	Barium	Phenol
C4-Naphthalenes[a]	1,3,5-trimethylbenzene	Cadmium	
Acenaphthylene	1,2,4-trimethylbenzene	Chromium	
Acenaphthene		Copper	
Fluorene		Cyanide	
C1-Fluorenes[a]		Iron	
C2-Fluorenes[a]		Lead	
C3-Fluorenes[a]		Manganese	
Phenanthrene		Mercury	
Anthracene		Nickel	
C1-Phenanthrenes/Anthracenes[a]		Selenium	
C2-Phenanthrenes/Anthracenes[a]		Silver	
C3-Phenanthrenes/Anthracenes[a]		Vanadium	
C4-Phenanthrenes/Anthracenes[a]		Zinc	
Fluoranthene			
Pyrene			
C1-Fluoranthenes/Pyrenes[a]			
Benzo[a]anthracene			
Chrysene			
C1-Chrysenes[a]			
C2-Chrysenes[a]			
C3-Chrysenes[a]			
C4-Chrysenes[a]			
Benzo[b]fluoranthene			
Benzo[k]fluoranthene			
Benzo[e]pyrenea			
Benzo[a]pyrene			
Perylene[a]			
Indeno[1,2,3-cd]pyrene			
Dibenzo[a,h]anthracene			
Benzo[g,h,i]perylene			
2-Methylnaphthalene			

Note: EPA - U.S. Environmental Protection Agency
PAH - polycyclic aromatic hydrocarbon
PVOC - petroleum volatile organic compounds

[a] Additional PAHs to be analyzed in sediment only for comparison to *Equilibrium Partitioning Sediment Benchmarks* (U.S. EPA 2003).

Tables

Table D-1 – Summary Statistics for Soils on the ComEd, LaSalle Chestnut, Division-Halsted and City Right-of-Way Parcels
North Station Operable Unit
Site-Specific Work Plan

Analyte	Residential SL[a] (ug/kg)	[Min] (ug/kg)	[Max] (ug/kg)	# Sample Results Above Residential SL	Total # Samples Analyzed	# Sample Results Above MDL	% Samples Analyzed Above MDL	Min MDL (ug/kg)	Max MDL (ug/kg)
VOCs									
Benzene	*1,100*	2	730,000	67	284	109	**38.38**	3	100
Xylenes, Total	*630,000*	5	860,000	2	284	112	**39.44**	4	100
SVOCs									
2-Methylnaphthalene	*310,000*	85	7,670,000	9	167	72	**43.11**	330	2200
3,3-Dichlorobenzidine	*1,100*	6,000	6,000	1	131	1	0.76	700	4,000
Dibenzofuran	*7,800*	55	137,000	1	167	59	**35.33**	300	2,200
PAHs									
Benzo(a)anthracene	*150*	32	745,000	211	379	234	**61.74**	25	530
Benzo(a)pyrene	*15*	30	460,000	257	379	257	**67.81**	20	400
Benzo(b)fluoranthene	*150*	27	350,000	203	379	227	**59.89**	25	530
Benzo(k)fluoranthene	*1,500*	33	170,000	117	379	228	**60.16**	25	530
Chrysene	*15,000*	38	696,000	37	284	206	**72.54**	25	530
Dibenz(a,h)anthracene	*15*	29	83,000	229	379	229	**60.42**	20	530
Indeno(1,2,3-cd)pyrene	*150*	29	160,000	180	371	211	**56.87**	25	17,000
Naphthalene	*3,600*	26	8,680,000	93	377	231	**61.27**	28	530
Pyrene	*1,700,000*	30	1,900,000	1	284	214	**75.35**	25	400
Metals									
Arsenic, Total[b]	*13,000*	23	44,500	37	282	279	**98.94**	10	NA
Lead, Total	*400,000*	10	2,100,000	4	260	259	**99.62**	NA	NA

Table D-1 – Summary Statistics for Soils on the ComEd, LaSalle Chestnut, Division-Halsted and City Right-of-Way Parcels
North Station Operable Unit
Site-Specific Work Plan

NOTES:

Screening levels (SL) are primarly based on USEPA Regional Screening Levels (RSL) and taken from the hierarchy of SLs developed for the Integrys Business Support LLC Manufactured Gas Plant sites in the multi-site program (Exponent, Risk-Assessment Framework Addendum, April 2011).

Bolded percentages indicate analytes were detected above SL in more than 5% of the samples.

[a] Soil samples screened against the residential soil screening values in the IBS Multi-Site Screening Level Hierarchy.

[b] Background concentration of arsenic in metropolitan counties of IL are 13.0 mg/kg (IL TACO-Table G). Total arsenic screened against background in this line.

[Max] - Maximum concentration

[Min] - Minimum concentration

MDL – Method detection limit

PAH - Polycyclic aromatic hydrocarbon

PCB - Polychlorinated biphenyl

SL - Screening level

SVOC - Semivolatile organic compound

ug/kg - Micrograms per kilogram

VOC - Volatile organic compound

Table D-2 – Site-Specific COPCs for Soil, Groundwater, Sediment and Surface Water
North Station Operable Unit
Site-Specific Work Plan

COPCs	Parcels			
	ComEd, LaSalle Chestnut, Division-Halsted, and City Right-of-Ways	**Division and Halsted**	**Old Town Village West**	**North Branch Canal**
Soil				
North Station Site-Specific COPC list[a]	X			
Multi-site RAF COPC list[b]		X	X	
PCBs		X	X	
TCL VOCs			X	
Groundwater				
North Station Site-Specific COPC list[a]	X	X	X	
Total antimony	X	X	X	
Total lead	X	X	X	
Available cyanide	X	X	X	
Phenol	X	X	X	
Styrene	X	X	X	
Sediment				
Multi-Site RAF COPC list[b]				X
Surface Water				
Multi-Site RAF COPC list[b]				X

NOTES:

X - Parameter selected as COPC

Shaded box indicates that matrix does not apply to the parcel.

[a] North Station Site-Specific COPC list includes: PVOCs from the multi-site RAF list, PAHs form the multi-site RAF list, 2-methylnaphthalene, dibenzofuran, total arsenic, total lead, and PCBs.

[b] The constituents on the Multi-Site RAF COPC list are presented in Appendix D-1.

COPC - Constituants of potential concern

PAH - Polycyclic aromatic hydrocarbon

PCB - Polychlorinated biphenyl

PVOC - Petroleum VOC

RAF - Risk Assessment Framework

TCL - Target Compound List

VOC - Volatile organic compound

APPENDIX E

VAPOR INTRUSION ASSESSMENT

APPENDIX E1

TIERS 1, 2 AND 3 SOIL VAPOR INTRUSION ASSESSMENT

Appendix E1

Soil Vapor Intrusion Assessment

Former North Station Manufactured Gas Plant

This appendix describes the soil vapor intrusion (VI) assessment prepared for the People's Gas Light and Coke Company (PGL) Former North Station Manufactured Gas Plant (MGP) facility based on the United States Environmental Protection Agency's (USEPA) *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*, November 2002 (USEPA, 2002) and guidance provided by USEPA during a meeting with Integrys Business Solutions, LLC (IBS) on December 17, 2010. As recommended by USEPA in that meeting, multiple lines of evidence are provided for the proposed VI assessment in addition to the tiered assessment outlined in the USEPA guidance document (USEPA, 2002). The assessment includes:

- Tier 1 assessment findings, including source material composition and location, and identification of potential risks of indoor inhalation;
- Tier 2 assessment findings, including evaluation of available data (measured and reasonably estimated concentrations of contaminants in groundwater and soil);
- Tier 3 assessment findings, including a OU-specific assessment; and
- Assessment conclusions.

The current layout of the North Station Operable Unit (OU), showing land formerly owned and occupied by PGL, is presented in Figure 2.

Tier 1 – Primary Screening

The primary screening questions are intended to help quickly screen out sites at which the VI pathway should not need further consideration. These questions lead to determination of the presence of potential risks of indoor inhalation due to vapor intrusion and, if present, whether immediate action may be warranted.

Q1. Are chemicals of sufficient volatility and toxicity known or reasonably suspected to be present in the subsurface?

Q1 Answer: Yes

The current layout of the North Station OU is shown in Figure 2. As outlined on Figure 2, the OU will be addressed in terms of four different parcels: the ComEd parcel, the Kingsbury Street parcel, the LaSalle Chestnut parcel, and the Division Halsted parcel. Numerous investigations were performed on various parcels on and adjacent to the OU over a period exceeding ten years.

Investigations conducted at the OU have revealed the presence of on-site soil and groundwater affected by potential MGP-related residuals. Tar was identified in many areas of the OU both in surface soil and subsurface soil (Figure 26). Localized and limited areas of tar-affected soils have been excavated during previous remedial actions (Figures 5, 6 and 7). However, residual MGP materials remain on the OU.

Historic soil data indicate the presence of volatile organic compounds (VOC), semi-VOCs (SVOC), polycyclic aromatic hydrocarbons (PAH), and inorganics in the subsurface at the OU. Historic soil data are located in Appendix H.

Vadose zone soils at the OU consist of fill and clay. Fill has been observed ranging from 0 to 12 feet thick, and generally overlaying a clay unit encountered from 1 to 12 feet bgs that has a lithologic thickness of greater than 36 feet.

Monitoring wells, temporary wells and temporary piezometers were installed and sampled once throughout the OU prior to 2005. Seven wells were installed on the ComEd parcel (Burns and McDonnell [B&McD] June 2002); 4 wells were installed on the LaSalle-Chestnut parcel (B&McD June 2006); and 2 wells were installed and sampled on the Division Halsted parcel (B&Mc October 2005, and ECS Midwest February 2011). Wells terminated in both the fill and within the clay till. Groundwater at the OU was observed at depths ranging from about 3 to 15 feet bgs.

Two constituents, benzene and naphthalene, were identified in groundwater on the OU at concentrations that exceed residential screening levels (SL) for vapor intrusion to indoor air (cancer risk $1x10^{-6}$) (Attachment E1-1). SLs used for this work were presented in the IBS MGP program Multi-Site Risk Assessment Framework (RAF) Addendum (Exponent April 2011). Wells containing these constituents at concentrations that exceed SLs were located on the southern portion of the ComEd parcel and the western edge of the LaSalle Chestnut parcel. It should be noted that the groundwater plume is not well defined as only one round of groundwater data was collected and the concentrations of constituents of potential concern (COPC) in groundwater are not known at the south, southeast and northeast perimeters of the OU.

Only one chlorinated compound was detected in groundwater. Chloromethane was detected at concentrations below the SL for vapor intrusion to indoor air (cancer risk $1x10^{-6}$) at two wells; one in the southwest corner of the ComEd parcel (PZ02) and one on the east edge of the LaSalle Chestnut parcel (SMW02) (Attachment E1-1). Historic groundwater data is presented in Appendix H.

A site-specific list of COPCs for soil gas has been developed for the OU based on the standard list of VI COPCs for Integrys MGP sites (Appendix E2) and the volatility and toxicity of constituents detected in soil and groundwater on the OU. Details of the site-specific screen for soil gas COPCs are attached (Appendix E3). The screening process evaluates whether a compound is both: 1) sufficiently volatile to result in potentially significant VI, and 2) sufficiently toxic to result in potentially unacceptable indoor air inhalation risks. If the compound fails either criterion, it is not considered further for this pathway. Results of the site-specific screening indicate the following compounds are soil gas COPCs for this OU: benzene, ethylbenzene, toluene, xylenes, 1,2,4-trimethylbenzene, naphthalene, 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, 1,1-dichloroethane, 1,1-dichloroethene, 2-hexanone, 4-methyl-2-pentanone (MIBK), acetone, bromodichloromethane, bromomethane, carbon disulfide, chloroethane, chloroform, chloromethane, methyl ethyl ketone, methylene chloride, and styrene.

Q2. Are currently (or potentially) inhabited buildings or areas of concern under future development scenarios located near subsurface contaminants found in Table 1?

Q2 Answer: Yes

Based on USEPA guidance (November 2002, USEPA), buildings within or proposed to be located within a critical distance of subsurface contaminants in soil or groundwater should be considered candidates for vapor intrusion investigation. In addition, during the meeting with USEPA and IBS on December 17, 2010, USEPA suggested that any building located over a former MGP structure should be considered a candidate for VI investigation. The critical distance for media affected by chlorinated compounds is 100 feet; it is 35 feet for media affected by petroleum hydrocarbons (ASTM, 2010). Affected soil in this section refers to soil that contains soil gas COPCs.

Eight buildings, or groups of buildings, have been identified on or near the OU that warrant discussion (Figure 34):

- Building 1, the substation control building - Located on the northern portion of the ComEd parcel and over the former 750,000 gallon oil tank. Building 1 controls power distribution to the near north side of downtown Chicago. Building 1 is constructed of cinderblock with a basement that can be accessed through several hatchways located in the floor of the main level. There is no elevator in the building. The basement ceiling is approximately 7.5 feet high and the floor is earthen (gravel). Sumps are located in the four corners of the basement that are used to mitigate effects of the shallow groundwater table, which ranges from 4.75 to 8.8 feet below ground surface (bgs) in the vicinity. The building is intermittently occupied (people are "in and out") by 2-3 people each day. ComEd reports that drilling underneath this building is not possible due to underground structures.
- Building 2, the maintenance building - Located on the southern portion of the ComEd parcel and partially over a former Oil Tank/Relief Holder. The building does not have a basement. Occupancy and construction of this building is unknown.
- Buildings 3 and 4, pump houses 1 and 2 – Located on the west side of the ComEd parcel. These are small sheds with unknown occupancy and construction. . The buildings do not have basements. These buildings are located over the estimated groundwater plume (Attachment E1-1).
- Building 5, the Shiani Furniture building – Located on the Division parcel. Building 5 is a three-story brick building. Occupancy and additional construction information for this building is unknown. This building is located within approximately 50 feet of borings where stained soil was observed on the ComEd parcel (boring SP27, Figure 26).
- Building Group 6, apartments east of the OU – Located along the east side of Crosby Street along the length of the OU. The apartments appear to be occupied. Construction information for these buildings is unknown. Some remediation was performed at this property prior to construction of the apartments and details of the remediation have been requested from the state of Illinois. This group of buildings is located within approximately 100 feet of borings where VI COPCs have been detected or the estimated extent of the groundwater plume (Attachment E1-1, Figure 26, Appendix H).
- Building Group 7, apartments south of the OU – Located along the south side of Hobbie Street, between Crosby and Kingsbury Streets, along the length of the OU. The apartments appear to be occupied. Construction information for these buildings is unknown. This group of buildings is located within either approximately 100 feet of borings where VI COPCs have been detected or the estimated extent of the groundwater plume (Attachment E1-1, Figure 26, Appendix H).
- Building Group 8, apartments south of the OU – Located along the south side of Hobbie Street, between Kingsbury Street and the river, along the length of the OU. The apartments appear to be occupied. Construction information for these buildings is unknown. This group of buildings is located within approximately 100 feet of borings where tar was observed in subsurface clay fractures on the ComEd parcel (boring SP85, Figure 26).

There is potential for contaminant migration via preferential pathways created by utility corridors on the OU. Sewer, electric, gas and water supply lines are located beneath the vacated Kingsbury Street, Hobbie Street, and Crosby Street. Based on the limited groundwater data available, the utility lines along vacated Kingsbury Street traverse areas within estimated groundwater plumes where concentrations of benzene and naphthalene exceed SLs for vapor intrusion to indoor air (cancer risk $1x10^{-6}$). Conclusions cannot yet be made about utilities along the south and east portions of the site where the limited historic groundwater data does not define groundwater plume boundaries.

Except for along utility pathways, the potential for contaminant migration via preferential pathways beyond the currently estimated extents and areas of known contamination is not likely based on soil type. Vadose zone soils are generally fill and clay.

Q3. Does evidence suggest immediate action may be warranted to mitigate current risks?

Q3 Answer: No

No odors, hazardous atmospheres, or flooding have been reported in buildings on or near the OU, nor have any physiological effects to building residents.

Tier 2 – Secondary Screening

The secondary screening questions are intended to allow rapid screening of available site data using measured or reasonably estimated concentrations of contaminants in groundwater and/or soil gas. Since available site data is in the form of contaminant concentrations in soil and groundwater from wells located near but not directly underneath the buildings of concern, this is considered to be reasonably estimated data and is sufficient for screening and comparison against generic SLs. Other assumptions and limitations of this data are discussed below.

Q4: Are indoor air quality data available?

Q4 Answer: No

Q4(c). Is there any potential contamination (source of vapors) in the unsaturated soil at any depth above the water table?

Q4(c) Answer: Yes.

Tar, soil staining, and detections of VI COPCs have been identified in many areas of the OU both in surface soil and subsurface soil (Attachment E1-2). Historic soil data also indicate the presence of VOCs, SVOCs, PAHs, and inorganics in the subsurface at the OU.

Q4(g). Do measured or reasonably estimated soil gas concentrations exceed the generic target media-specific concentrations given in Tables 2(a), 2(b), or 2(c)?

Q4(g) Answer: Yes.

Soil gas concentrations were estimated based on groundwater concentrations. Naphthalene and benzene concentrations exceed the IBS Multi-Site SLs developed for groundwater to vapor contaminant migration (cancer risk 10^{-6}) for residential land use. The estimated areas of this effect (based on one round of groundwater sampling) are shown on the figure of Attachment E1-1.

Q5(a). Do groundwater and/or soil gas concentrations for any constituents of potential concern exceed target media-specific concentrations by a factor of greater than 50?

Q5(a) Answer: Yes.

Based on the limited groundwater data available, concentrations of benzene exceeded 50 times the IBS Multi-Site SLs for groundwater to vapor contaminant migration (cancer risk 10^{-6}) for residential land use in two groundwater samples on the southern portion of the ComEd parcel (Attachment E1-1). Concentrations of benzene in one sample collected from wells SMW05 and SMW04 exceeded 50 times the SL.

Based on the limited groundwater data available, concentrations of naphthalene exceeded 50 times the IBS Multi-Site SLs for groundwater to vapor contaminant migration (cancer risk 10^{-6}) for

residential land use in three groundwater samples along the along the Kingsbury Street ROW; one on the southern portion of the ComEd parcel (SMW04); one on the LaSalle Chestnut parcel (SMW02); and one on the Halsted parcel (SP-14) (Attachment E1-1).

Tier 3 – OU-specific Assessment

Since the primary and secondary screening did not exclude the potential existence of a vapor intrusion pathway for the site, the guidance recommends a site-specific assessment. The evidence presented in the above discussions, along with guidance from USEPA, are considered in a multiple-lines of evidence approach to selecting site-specific assessment techniques.

Q6(a): Have the nature and extent of contaminated soil vapor, unsaturated soil, and/or groundwater as well as potential preferential pathways and overlying building characteristics been adequately characterized to identify the most likely-to-be-impacted buildings?

Q6(a) Answer: Yes.

Eight buildings, or groups of buildings, have been identified as most-likely-to-be-impacted. The buildings and their relationship to affected areas on the OU are described in the response to Question Q2. They are discussed further by parcel below along with proposed vapor sampling to evaluate VI risk at the buildings. Proposed sampling locations are presented on Figure 34 and detailed in the SSWP. Sampling locations may be modified in field if it is not possible to sample at a proposed location due to obstructions, infrastructure or safety issues.

ComEd Parcel

The ComEd parcel is an active substation. To date, no soil gas samples have been collected on this parcel. Additional data regarding the occupancy and usage of the buildings will be collected as part of implementation of the SSWP.

Buildings 1 and 2 are located over former MGP structures and are candidates for further investigation. Building 1 has a basement and sump pumps to control groundwater seepage into the building due to the shallow groundwater elevation relative to the elevation of the basement slab. Subslab samples are not possible if groundwater is in contact with the basement slab. Therefore, sump headspace samples will be collected in Building 1in lieu of subslab samples, and a subslab vapor sample will be collected in Building 2.

Buildings 3 and 4 are shed-sized pump houses and not likely occupied. Building 4 may be partially located over a former purifying house. No sampling is proposed for these buildings at this time. In comments provided on the Marinette Former MGP Site-Specific Work Plan, Revision 1, received on September 1, 2011, USEPA recommends that “any buildings that could be occupied (current or future) for 1 hour or more per day should be considered in the VI assessment.” When use and occupancy information for Buildings 3 and 4 is obtained from the owner, this criteria will be will be utilized to consider additional VI assessment.

Division Parcel

Building 5 is not located over any former MGP structures, but is located within approximately 50 feet of borings where stained soil was observed on the ComEd parcel (boring SP27, Figure 26). Because the northern extent of potential MGP effects is not defined on the OU, Building 5 is a candidate for further investigation. Exterior soil gas probes are proposed to be advanced along each side of the building foundation. Following proposed Remedial Investigation (RI) sampling, multiple lines of evidence will be evaluated to determine if additional VI sampling is required at Building 5.

Old Town Village West Parcel

Two residential units of Building Group 6 are located over a former building that was part of the former MGP and contained an aboveground tar vat. The two residential units are candidates for further investigation. Subslab vapor probes are proposed for these units.

Residential Building Group 6 is also located within the critical distance of affected media on the OU (estimated extend of groundwater plume, observed tar in clay fractures, or detected VI COPCs in soil). To date, no soil gas samples have been collected on the Old Town Village West parcel. Additional VI investigation is recommended for the building groups.

Exterior soil gas sampling is proposed for the building group. The east boundary of the OU is not well defined in terms of extent of affected groundwater. Limited groundwater data is available to evaluate the extent of the groundwater plumes in the directions of the building groups. In addition, utilities running underneath Hobbie and Crosby Streets may act to intercept the migration of tar and affected soil vapor from the OU to off-site locations. As was proposed for the Former South Station MGP Site, exterior soil gas samples will be collected, along with additional soil and groundwater samples, to further characterize the environment around these building groups.

Additional VI evaluation will be performed for Building Group 6 when additional groundwater, soil and soil vapor data is available for the areas adjacent to the building groups.

South Residential Properties

Residential Building Groups 7 and 8 are located within the critical distance of affected media on the OU (estimated extend of groundwater plume, observed tar in clay fractures, or detected VI COPCs in soil). To date, no soil gas samples have been collected on these properties. Additional VI investigation is recommended for these building groups.

Exterior soil gas sampling is proposed for these building groups. The south boundary of the OU is not well defined in terms of extent of affected groundwater. Limited groundwater data is available to evaluate the extent of the groundwater plumes in the directions of the building groups. In addition, utilities running underneath Hobbie and Crosby Streets may act to intercept the migration of tar and affected soil vapor from the OU to off-site locations. As was proposed for the Former South Station MGP Site, exterior soil gas samples will be collected, along with additional soil and groundwater samples, to further characterize the environment around these building groups.

Additional VI evaluation will be performed for Building Groups 7 and 8 when additional groundwater, soil and soil vapor data is available for the areas adjacent to the building groups.

Q6(b): Are you conducting an Environmental Indicator (EI) determination and are you using an appropriate and applicable model?

Q6(b) Answer: No.

Q6(d): Are subslab soil gas data available?

Q6(d) Answer: No.

Current Evaluation Conclusion

The VI evaluation performed to date according to the 2002 USEPA Guidance and the outcome of the December 17, 2010 meeting with USEPA and Integrys indicates additional assessments will be useful to evaluate potential soil vapor exposure risk. Current OU data indicates that the

potential VI pathway cannot be eliminated. For this reason, direct evidence (exterior soil gas and subslab soil gas data) and indirect evidence (additional soil and groundwater data), will be collected to further evaluate the VI exposure pathway as part of the RI. Procedures for performing the following next steps are documented in the 2011 SSWP:

- Collect additional building information after gaining access;
- Collect sump headspace samples at Building 1 and a subslab vapor sample at Building 2 based on the rationale provided in the response to Question Q6(a);
- Collect subslab vapor samples at the two units of Building Group 6 that are located above the former building containing the aboveground tar vat based on the rationale provided in the response to Question Q6(a);
- Collect exterior soil gas samples around Building 5 and between the OU and Building Groups 6, 7 and 8 based on the rationale provided in the response to Question Q6(a);
- Collect additional soil and groundwater samples. Additional soil and groundwater samples will be collected on site as proposed in the 2011 SSWP. The need for further VI evaluation beyond the scope of this document will be considered once the additional soil, groundwater and soil gas samples are collected; and
- Perform additional VI evaluation for Building Groups 6, 7 and 8 after additional groundwater, soil and soil vapor data is available for the areas adjacent to the building groups.

Proposed sampling is shown on Figure 34.

Re-evaluation of additional VI assessment needs after collection of RI data will include the following:

- Identification of any additional buildings located within the critical distance of affected soil or groundwater;
- If additional sampling is warranted to evaluate the potential for VI at any buildings that are located within the critical distance of affected soil gas, soil or groundwater, sampling will be implemented according to the following rules:
    - Exterior soil gas samples that can represent soil gas underneath a building will be collected around the perimeter of buildings identified within the critical distance of affected soil or groundwater. Samples will be analyzed for the soil gas COPCs presented in Appendix E3. Results will be compared to the IBS Multi-Site SLs developed for shallow soil gas for residential land use (cancer risk 10^{-6}). If results of one or more rounds of sampling exceed the SLs, and the building is currently occupied, the assessment will proceed with sublab sampling in the building (see below);
    - Subslab vapor samples will be collected underneath any buildings identified over former MGP structures or MGP-related residuals (e.g. tar or soil containing MGP soil gas COPCs) or where exterior soil gas sampling results have indicated the need for subslab sampling (see above). Samples will be analyzed for the soil gas COPCs presented in Appendix E3. Results will be compared to the IBS Multi-Site SLs developed for shallow soil gas for residential land use (cancer risk 10^{-6}). If results of one or more rounds of sampling exceed the SLs, and the building is currently occupied, the assessment will proceed with indoor air sampling in the building (see below);

- Indoor air samples will be collected inside buildings where subslab vapor sampling results have indicated the need for indoor air sampling (see above). Samples will be analyzed for the soil gas COPCs presented in Appendix E3. Results will be compared to the IBS Multi-Site SLs developed for indoor air (per building use and cancer risk 10^{-6}).

- Identification of the areal extent of property that requires VI risk evaluation for future construction or use scenarios. This area will include land located within the critical distance of affected soil or groundwater. Determination of the extent of affected groundwater will be completed prior to this step;

- Collection of soil gas samples on property that requires VI risk evaluation for future construction or use scenarios. Samples will be collected at a density of approximately one sample for every 3.5 acres of land and at locations where the upper range of affected soil and groundwater are likely present (e.g. over former MGP structures, tar, or affected soil or groundwater). Samples will be analyzed for the soil gas COPCs presented in Appendix E3. Results will be compared to the IBS Multi-Site SLs developed for shallow soil gas for residential land use (cancer risk 10^{-6}). Documentation of the results will be used to evaluate VI risk in the risk assessment, included in the RI Report;

- Identification of utility corridors that traverse affected areas of the OU. Affected areas include areas within the critical distance of affected soil or groundwater. Determination of the extent of affected groundwater will be completed prior to this step; and

- Collection of soil gas samples within the bedding material of utility corridors that traverse affected areas of the OU. Samples will be collected from a representation of utility corridors that cross the OU. Larger diameter utility corridors and utility corridors that traverse significantly affected areas of the OU will be selected for soil gas sampling. Samples will be analyzed for the soil gas COPCs presented in Appendix E3. Results will be compared to the IBS Multi-Site SLs developed for shallow soil gas for residential land use (cancer risk 10^{-6}). If results exceed the SLs, further assessment will be considered.

Two rounds of sampling will be conducted in alternate seasons for any given matrix (soil gas, subslab vapor, or indoor air) to verify sampling results before a no further action decision can be made regarding the VI assessment.

The soil gas COPC list may be modified based on sampling results. If a soil gas COPC is not detected in two vapor sampling events within the same source area, it may be removed from the COPC list.

If site-specific conditions indicate that an alternative VI plan is appropriate, the alternative plan will be communicated to USEPA prior to implementation. Examples of alternative VI plans may be to proceed directly to subslab or indoor air sampling if very high concentrations of soil gas COPCs are detected in soil adjacent to an occupied building, or to forego indoor air sampling at a building with high concentrations of soil gas COPCs in subslab vapor if IBS owns the building and they intend to demolish it.

Attachments: (E1-1) Groundwater Results that Exceed Residential Screening Levels for Protection of Indoor Air (Cancer Risk 10^{-6})

(E1-2) Observations of Tar and Staining and Detections of COPCs in Soil

NATURAL RESOURCE TECHNOLOGY

GROUNDWATER RESULTS THAT EXCEED RESIDENTIAL SCREENING LEVELS FOR PROTECTION OF INDOOR AIR (CANCER RISK 10^{-6})

SITE SPECIFIC WORK PLAN
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

MW-4
Benzene: ND
Naphthalene: ND

SMW03
Benzene: ND
Naphthalene: ND

MW-1 - Tar

PZ01
Benzene: 11 µg/L
Naphthalene: ND

SMW05
Benzene: 19,000 µg/L
Naphthalene: 23 µg/L

35-ft

35-ft

SMW02
Benzene: 0.6 µg/L
Naphthalene: 2 µg/L

SMW04
Benzene: 15,000 µg/L
Naphthalene: 6,800 µg/L

PZ02
Benzene: 1 µg/L
Naphthalene: ND

SP-14
Benzene: 75 µg/L
Naphthalene: 1,200 µg/L

SP-5
Benzene: ND µg/L
Naphthalene: NA

SMW02
Benzene: 68 µg/L
Naphthalene: 1,200 µg/L

SP-12
Benzene: ND
Naphthalene: 0.48 µg/L

B-2

PZ02

SP-11
Benzene: ND
Naphthalene: ND

PZ03

35-ft

SP-2
Benzene: ND
Naphthalene: ND

SMW01
Benzene: 26 µg/L
Naphthalene: ND

PZ01
Benzene: ND
Naphthalene: 0.2 µg/L

SMW04
Benzene: 16 µg/L
Naphthalene: ND

SMW03
Benzene: 71 µg/L
Naphthalene: ND

N E S W

0 50 100
SCALE IN FEET

BENZENE SCREENING VALUE = 5 µG/L
NAPHTHALENE SCREENING VALUE = 4 µG/L
ND - NON-DETECT, NA - NOT ANALYZED

Screening levels (SL) are based on USEPA Regional Screening Levels (RSL) for indoor air and taken from the hierarchy of SLs developed for the Integrys Business Support LLC Manufactured Gas Plant sites in the multi-site program (Exponent, Risk-Assessment Framework Addendum, April 2011).

- ESTIMATED EXTENT OF BENZENE AT CONCENTRATIONS EXCEEDING SCREENING LEVEL
- DASHED WHERE INFERRED
- 35-FOOT BOUNDARY FOR POTENTIAL SOIL GAS IMPACTS – BENZENE
- DASHED WHERE INFERRED
- ESTIMATED EXTENT OF NAPHTHALENE AT CONCENTRATIONS EXCEEDING SCREENING LEVEL
- DASHED WHERE INFERRED
- 35-FOOT BOUNDARY FOR POTENTIAL SOIL GAS IMPACTS - NAPHTHALENE
- DASHED WHERE INFERRED

- MONITORING WELL LOCATION
- SOIL BORING LOCATION
- OU BOUNDARY

PROJECT NO: 2034/5.1

ATTACHMENT: E1-1

DRAWN BY/DATE:	TDC	11/28/11
CHECKED BY/DATE:	TBN	11/28/11
APPROVED BY/DATE:	SLM	11/28/11

NATURAL RESOURCE TECHNOLOGY

SITE SPECIFIC WORK PLAN
NORTH STATION OPERABLE UNIT
CHICAGO, ILLINOIS

OBSERVATIONS OF TAR AND STAINING AND DETECTIONS OF VAPOR INTRUSION COPCS IN SOIL

0 25 50 75
SCALE IN FEET

NOTE:
COPC - CONSTITUENT OF POTENTIAL CONCERN

- SOIL BORING - NO DETECTIONS
- SOIL BORING - DETECTIONS
- OU BOUNDARY
- TEST PIT LOCATION
- RIVER

SOIL BORING LOG OBSERVATIONS

- NO IMPACTS OBSERVED
- DNAPL/TAR IN CLAY FRACTURES
- LNAPL/SHEEN
- STAINED SOIL/ODOR/PID RESPONSE
- REFUSAL/NOT LOGGED

PROJECT NO: 2034/5.0

ATTACHMENT: E1-2

DRAWN BY/DATE:	TDC	8/2/2011
CHECKED BY/DATE:	TBN	8/2/2011
APPROVED BY/DATE:	SLM	8/11/2011

APPENDIX E2

INITIAL VAPOR INTRUSION SCREEN FOR INTEGRYS MGP SITES

Appendix E2

Initial Vapor Intrusion Screen for Integrys MGP Sites
(Originally Prepared for the South Station Former MGP Site, 2010)

An initial vapor intrusion screening assessment was performed for the MGP-related constituents being evaluated at the Integrys MGP sites. This list of MGP-related constituents under consideration is presented in the Risk Assessment Framework (Exponent 2007), and in the attached Table E2-1. This initial screening followed the general approach of the Tier 1/Question 1 screening process presented in Table 1 of the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (U.S. EPA 2002). This process evaluates whether a compound is both: 1) sufficiently volatile to result in potentially significant vapor intrusion and 2) sufficiently toxic to result in potentially unacceptable indoor air inhalation risks. If the compound fails either criterion, it is not considered further for this pathway.

Within the subsurface vapor intrusion guidance, the single factor used to determine volatility was whether a compound had a Henry's Law constant of 1×10^{-5} atm-m^3/mole or greater (U.S. EPA 2002). The more current approach used by EPA for determining volatility from a risk assessment perspective is presented in the Regional Screening Level (RSL) technical document (U.S. EPA 2009). For the RSLs, two factors are used to determine volatility of a compound: that a compound have a Henry's Law constant of 1×10^{-5} atm-m^3/mole or greater in addition to having a molecular weight less than 200 g/mole. This classification of a whether or not a compound was sufficiently volatile was the first criterion used in this assessment to characterize the MGP-related compounds (Table E2-1). Most MGP-related constituents are not sufficiently volatile to require evaluation for the vapor intrusion pathway.

For those MGP-related compounds that are sufficiently volatile, the second criteria of inhalation toxicity was considered (i.e., is the compound sufficiently toxic). In the 2002 subsurface vapor intrusion guidance, EPA first determined the maximum pure component vapor phase concentration of each volatile compound, and then determined if that maximum concentration would result in human health risks above acceptable risk-based targets (cancer risk of 1×10^{-6} or hazard quotient of 1). For this assessment, sufficiently toxic was defined more simply by the presence of an inhalation toxicity value in a source currently recognized by EPA (as presented in the RSL technical guidance document, U.S. EPA 2009). This simplified approach to determining sufficient toxicity is potentially more conservative (i.e., it could screen in more compounds than the 2002 EPA approach). If a compound was found to be both sufficiently volatile and sufficiently toxic, then it was determined to be a compound of potential concern (COPC) for the vapor intrusion pathway. For compounds determined to be COPCs through this vapor intrusion screening process, measures of applicable media (i.e., soil gas or indoor air) would be required if the compound is detected at an MGP site in soil or groundwater within close proximity (within 100 feet) of buildings. This initial screening resulted in a short list of COPCs for the vapor intrusion pathway: benzene, toluene, ethylbenzene, xylenes (BTEX), 1,2,4-trimethylbenzene, and naphthalene (Table E2-1).

References

U.S. EPA. 2002. OSWER draft guidance for evaluating the vapor intrusion to indoor air pathway from groundwater and soils (subsurface vapor intrusion guidance). EPA530-F-02-052. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA. 2009. Regional screening levels for chemical contaminants at Superfund sites. Available at: www.epa.gov/region/superfund/ prg/index.html. Updated December 2009. Accessed April 27, 2010. U.S. Environmental Protection Agency, Regions 3, 6, and 9.

Appendix E2 Table E2-1. MGP-related compounds of potential concern: Step 1 screening assessment for vapor intrusion

Project Compound List	Criterion 1: Sufficiently Volatile	Criterion 2: Sufficiently Toxic	Vapor Intrusion COPC
PVOCs			
Benzene	YES	YES	**X**
Ethylbenzene	YES	YES	**X**
Toluene	YES	YES	**X**
Xylenes (total)	YES	YES	**X**
1,2,4-Trimethylbenzene	YES	YES	**X**
1,3,5-Trimethylbenzene	YES	NA	
Semivolatile Organic Compounds			
PAHs			
Acenaphthene	YES	NA	
Acenaphthylene	YES[a]	NA	
Anthracene	YES	NA	
Benzo[a]anthracene	NO	--	
Benzo[b]fluoranthene	NO	--	
Benzo[k]fluoranthene	NO	--	
Benzo[a]pyrene	NO	--	
Benzo[g,h,i]perylene	NO[b]	--	
Chrysene	NO	--	
Dibenz[a,h]anthracene	NO	--	
Fluoranthene	NO	--	
Fluorene	YES	NA	
Indeno[1,2,3-cd]pyrene	NO	--	
Naphthalene	YES	YES	**X**
Phenanthrene	YES[c]	NA	
Pyrene	YES	NA	
2-Methylnaphthalene	YES	NA	
Phenols			
2,4-Dimethylphenol	NO	--	
2-Methylphenol	NO	--	
4-Methylphenol	NO	--	
Phenol	NO	--	
Inorganics			
Aluminum	NO	--	
Antimony	NO	--	
Arsenic	NO	--	
Barium	NO	--	
Cadmium	NO	--	
Chromium	NO	--	
Copper	NO	--	
Cyanide	NO[d]	--	
Iron	NO	--	
Lead	NO	--	
Manganese	NO	--	
Mercury	NO[e]	--	
Nickel	NO	--	
Selenium	NO	--	
Silver	NO	--	
Vanadium	NO	--	
Zinc	NO	--	

(footnote on following page)

Table 1. (cont.)

-- – Compound not sufficiently volatile so criterion 2 not considered.
NA – Inhalation toxicity value not currently available from EPA-approved source.
COPC – compound of potential concern
PAH – polynuclear aromatic hydrocarbon
PVOC – petroleum volatile organic compound

Criteria 1: Sufficiently volatile. The determination of sufficiently volatile was updated to reflect the current two-pronged approach reflected in the Regional Screening Level (RSL) technical document, which considers a compound volatile if it has a Henry's Law constant of 1×10^{-5} atm-m^3/mole or greater and has a molecular weight less than 200 g/mole.

Criteria 2: Sufficiently toxic. This criterion is considered only if the compound is sufficiently volatile. A compound is considered to be sufficiently toxic if it has an inhalation toxicity value in the RSL tables (U.S. EPA 2009 [December]). If there is no inhalation toxicity value available in the RSL tables, then the compound is not considered further for this pathway, because of a lack of an EPA-recognized toxicity value that could be used in a risk assessment.

Vapor Intrusion COPC: Chemicals that meet both Criteria 1 and 2 are considered chemicals of potential concern requiring measurement in media applicable to a vapor intrusion assessment (e.g., soil gas, indoor air)

[a] Acenaphthylene is not listed in the RSL table, but based on its molecular weight (152.20 g/mole) and Henry's Law constant of 1.13×10^{-5} atm-m^3/mole, it is considered sufficiently volatile (source of data http://www.speclab.com/compound/c208968.htm).

[b] Benzo[g,h,i]perylene is not listed in the RSL table, but based on its molecular weight (276.34 g/mole) and Henry's Law constant of 1.6×10^{-6} atm-m^3/mole, it is not considered sufficiently volatile (source of data http://www.speclab.com/compound/c191242.htm).

[c] Phenanthrene is not listed in the RSL table, but based on its molecular weight (178.22 g/mole) and Henry's Law constant of 2.56×10^{-5} atm-m^3/mole, it is considered sufficiently volatile (source of data http://www.toronto.ca/health/pdf/cr_appendix_b_pah.pdf).

[d] Cyanide in soil is expected to be present in a nonvolatile form.

[e] Mercury in soil is expected to be present in a nonvolatile form, such as an inorganic salt.

APPENDIX E3

SITE-SPECIFIC COPC SCREEN FOR SOIL GAS

Appendix E3

Site-Specific Screen for VI COPCs at the North Station Former MGP Site

Vapor intrusion (VI) constituents of potential concern (COPC) for sites within the Integrys Business Solutions, LLC (IBS) Multi-Site program can be found in *Initial Vapor Intrusion Screen for Integrys MGP Sites* (Exponent 2010, Attachment E2). For the North Station former Manufactured Gas Plant (MGP) site, a supplemental screening assessment has been performed to address USEPA concerns regarding the potential presence of additional VI COPCs that are not on the standard VI COPC list for IBS sites and determine if any constituents should be added on a site-specific basis. This assessment considers the results of previous on-site soil, groundwater and soil gas sampling.

The supplemental VI COPC assessment was performed using the following screening techniques:

- Identifying analytes detected in site soil that are not already on the IBS Multi-Site MGP COPC list;
- Determining if these additional analytes are sufficiently volatile and toxic to be considered a soil gas COPC. The methods used to evaluate volatility and toxicity are outlined in *Initial Vapor Intrusion Screen for Integrys MGP Sites* (Exponent 2010, Attachment E2);
- Identifying analytes that exceed screening level (SL) concentrations in groundwater for vapor intrusion to residential indoor air (cancer risk $1x10^{-6}$) that are not already on the Multi-Site MGP COPC list; and

The results of this assessment are found on Table E3-1.

Thirty-one compounds were detected in site soils that were not evaluated in the *Initial Vapor Intrusion Screen for Integrys MGP Sites* (Exponent 2010, Attachment E2). Sixteen of the 31 compounds were both volatile and toxic enough to be considered VI COPCs. Those sixteen compounds are:

- 1,1,1-Trichloroethane
- 1,1,2,2-Tetrachloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- 2-Hexanone
- 4-Methyl-2-pentanone (MIBK)
- Acetone
- Bromodichloromethane
- Bromomethane
- Carbon disulfide

- Chloroethane
- Chloroform
- Methyl ethyl ketone (MEK)
- Methylene chloride
- Styrene

The remaining 15 constituents will not be carried forward as VI COPCs for soil gas analysis because they are not sufficiently volatile or toxic (Table E3-1).

Groundwater data was also screened for VI COPCs using the screening process described above. Chloromethane was detected in two groundwater samples and has been added to Table E3-1. Chloromethane is sufficiently volatile and toxic to be considered a VI COPC. There were no other site-specific groundwater constituents identified beyond those that were already identified during the soil screen.

An evaluation was also done to address elevated detection limits in some samples. Method detection limits (MDL) in historic soil samples were compared to the residential soil screening level (SL) from the IBS multi-site hierarchy of SLs for residential soil. Results indicate that five analytes had minimum MDLs that exceeded the residential soil SL; benzo(a)pyrene, dibenz(a,h)anthracene, indeno (1,2,3-cd)pyrene, and n-nitroso-dipropylamine. However, none of these analytes are volatile or toxic enough to be considered VI COPCs so they would not be carried forward as VI COPCs. Similarly, MDLs in historic groundwater samples were compared to the residential groundwater SLs for vapor intrusion to indoor air (cancer risk $1x10^{-6}$). Results indicate that no analytes consistently had minimum MDLs that exceeded the residential groundwater SLs for vapor intrusion to indoor air (cancer risk $1x10^{-6}$). Therefore, no additional analytes will be carried forward as VI COPCs based on elevated MDLs in the data set.

The final list of soil gas COPCs for the North Station former MGP site are presented in Table E3-2.

References

Exponent, 2010, "Initial Vapor Intrusion Screen for Integrys MGP Sites," prepared for the South Station Former MGP Site, Chicago, Illinois.

Tables: Table E3-1 – Site-Specific Screen for VI COPCs
Table E3-2 – VI COPCs for Soil Gas

Table E3-1 – Site-Specific Screen for VI COPCs
North Station Former MGP Site
Supplemental RI Activities - Vapor Intrusion

Analyte Detected On Site in Previous Sampling	Criterion 1: Sufficiently Volatile	Criterion 1: Sufficiently Toxic	VI COPC
1,1,1-Trichloroethane	YES	YES	X
1,1,2,2-Tetrachloroethane	YES	YES	X
1,1-Dichloroethane	YES	YES	X
1,1-Dichloroethene	YES	YES	X
2-Hexanone	YES	YES	X
3,3-Dichlorobenzidine	NO	---	
4,4-DDE	NO	---	
4-Chloroaniline	NO	---	
4-Methyl-2-pentanone (MIBK)	YES	YES	X
4-Nitroaniline	NO	---	
Acetone	YES	YES	X
Bis(2-ethylhexyl)phthalate	NO	---	
Bromodichloromethane	YES	YES	X
Bromomethane	YES	YES	X
Butyl benzyl phthalate	NO	---	
Carbazole	NO	---	
Carbon disulfide	YES	YES	X
Chloroethane	YES	YES	X
Chloroform	YES	YES	X
Chloromethane	YES	YES	X
cis-Dichloroethene	NO	---	
Dibenzofuran	NO	---	
Di-n-butyl phthalate	NO	---	
Methyl Ethyl Ketone (MEK)	YES	YES	X
Methylene chloride	YES	YES	X
PCB-1242	NO	---	
PCB-1248	NO	---	
PCB-1254	NO	---	
PCB-1260	NO	---	
PCBs, Total	NO	---	
Styrene	YES	YES	X

NOTES:
On this list are compounds (not including metals) detected in site soil and/or groundwater that are not
--- - Analyte fails criteria 1 (is the compound sufficiently volatile), therefore criteria 2 is not applicable.
PCB - Polychlorinated biphenyl
VI COPC - Vapor intrusion contaminant of potential concern

Table E3-2 – VI COPCs for Soil Gas
North Station Former MGP Site
Supplemental RI Activities - Vapor Intrusion

Type of COPC	Analyte
Integrys Sites[a]	Benzene
Integrys Sites[a]	Ethylbenzene
Integrys Sites[a]	Toluene
Integrys Sites[a]	Xylenes (total)
Integrys Sites[a]	1,2,4-Trimethylbenzene
Integrys Sites[a]	Naphthalene
Site-specific[b]	1,1,1-Trichloroethane
Site-specific[b]	1,1,2,2-Tetrachloroethane
Site-specific[b]	1,1-Dichloroethane
Site-specific[b]	1,1-Dichloroethene
Site-specific[b]	2-Hexanone
Site-specific[b]	4-Methyl-2-pentanone (MIBK)
Site-specific[b]	Acetone
Site-specific[b]	Bromodichloromethane
Site-specific[b]	Bromomethane
Site-specific[b]	Carbon disulfide
Site-specific[b]	Chloroethane
Site-specific[b]	Chloroform
Site-specific[b]	Chloromethane
Site-specific[b]	Methyl Ethyl Ketone (MEK)
Site-specific[b]	Methylene chloride
Site-specific[b]	Styrene

NOTES:

[a] COPC selected because it was screened in for Integrys sites in the Intitial Vapor Intrusion Screen for Integrys MGP Sites (Exponent 2010).

[b] COPC selected because it was screened through a site-specific evaluation for the North Station Former MGP Site.

COPC - Contaminant of potential concern

MGP - Manufactured gas plant

APPENDIX F

STANDARD OPERATING PROCEDURES (INCLUDED ON CD)

ONLY THE FOLLOWING STANDARD OPERATING PROCECURES ARE RELEVANT TO THIS DOCUMENT AND INCLUDED IN THIS APPENDIX:

SAS-01-01
SAS-01-02
SAS-02-01
SAS-02-02
SAS-03-01
SAS-03-02
SAS-03-03
SAS-04-01
SAS-04-02
SAS-04-03
SAS-04-04
SAS-05-01
SAS-05-02
SAS-05-03
SAS-05-04
SAS-05-05
SAS-05-06
SAS-05-07
SAS-06-01
SAS-07-01
SAS-07-02
SAS-07-03
SAS-08-01
SAS-08-02
SAS-08-03
SAS-08-04
SAS-08-05
SAS-08-07
SAS-09-01
SAS-09-02
SAS-11-01
SAS-11-05
SAS-11-06

SOP SERIES SAS-01
FILE AND DATA MANAGEMENT

STANDARD OPERATING PROCEDURE NO. SAS-01-01

FIELD ACTIVITY DOCUMENTATION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes procedures for documenting field activities and guidance on types and specificity of data to be recorded. Procedures are included for documentation on field logbooks, field forms, and/or field electronic data recorders. This standard is also applicable to photographic documentation collected to support field observations of site conditions and field data entries.

2.0 EQUIPMENT AND MATERIALS

- Field logbooks;
- Field forms;
- Camera and/or camcorder; and
- Waterproof pens with non-erasable ink.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 FORMAT

4.1 FIELD LOGBOOK

Field logbooks shall be bound books that are permanently assigned to a specific project. The cover of each logbook will provide the following identifying information:

- Name of project/site;
- Project number; and
- Book number.

The consultant's contact person(s), address and phone number should be recorded on the inside cover of the field logbook. Only field logbooks with pre-numbered pages shall be used and no pages shall be removed from the logbook.

4.2 Field Forms

Field recording forms are also used for data collection in a variety of activities. The forms include logs for boreholes, well construction, well sampling, etc. It is not necessary to duplicate information recorded on field forms into the field logbooks.

5.0 ENTRIES

5.1 Daily Entries

At the beginning of each daily entry, the following information is recorded:

- Date;
- Time of arrival at the site;
- Weather conditions;
- Physical/environmental conditions at the field site;
- Field personnel present and their responsibilities;
- Level of personal protection if other than Level D; and
- Signature of the person making the entry.

For investigation activities, the entry for each day will contain a complete record of the day's activities including, but not limited to, the following information, unless the data is recorded on field forms.

- Names and titles of site visitors;
- Information concerning sampling changes, scheduling modifications and change orders.
- Location, description and log of photographs of sampling points;
- Description of reference points for maps and photographs of sampling site;
- Field observations;
- Field measurements;
- Equipment calibration and maintenance;
- Sample identification numbers;
- Name of laboratory and overnight delivery service provider or name of laboratory courier and time of sample pick-up;
- Sample documentation, such as chain-of-custody form numbers and shipment air bill numbers;
- Decontamination procedures used;
- Documentation for investigation-derived wastes, such as contents and approximate waste volume in each drum, and number of drums generated;
- Time of departure from the site; and
- Signature of person responsible for observations and date.

Field logbooks are also used as a daily record for remediation activities. General entries similar to the ones listed above are used in remediation activity logbooks. In addition, daily entries regarding excavation activities, waste disposal quantities and methods of transport, system performance data from any remediation systems (e.g. soil vapor extraction systems, recovery well systems, etc.), system or equipment calibration or maintenance performed, and any other pertinent information regarding daily activities.

All logbook entries shall be printed legibly using a pen with waterproof, non-erasable ink. Any lines or pages inadvertently left blank will have a single line drawn through them with the logging person's initials and date written on the line.

When a field log form is used to record field data, all form fields will be completed in full on a daily basis. If a specific data entry area is not applicable, it will be clearly marked as such with the use of "NA" or a dashed

line drawn through it. A single line will be drawn through any unused data entry areas on the form with the field person's signature on the line.

5.2 Entry Changes

Entry changes should be avoided by carefully entering data in the logbook. If a change is required, it should be made by drawing a single line through the original entry such that the original entry is not obscured and entering the correct information next to the original entry. The change in entry will be initialed and dated by the logger. Only the person making the entry may change it.

If there is a change in the person recording field notes during a particular day, that person shall be identified in the logbook prior to making entries. The new logger shall sign and date the logbook at the beginning and end of his entry.

6.0 FORM AND LOGBOOK MANAGEMENT

Site-specific field logbooks and forms will be kept in the in-office project file when not in use. If forms or logbooks are used in the field for an extended period of time, copies of used pages will be made, delivered to the office, and filed in the project file on a periodic basis.

7.0 PHOTOGRAPHIC AND VIDEO RECORDS

7.1 Photographic Record

Photographs shall be taken in the field on a daily basis to document field activities. Field log entries for each photograph may include:

- Photographer’s name;
- Project name and project number;
- Roll and frame number, or digital photograph number;
- Date and time;
- Description of photograph including sampling point, sample name, depth and other relevant identifying information, such as direction faced (e.g. “looking south”) and relationship of photograph to site features.

Photograph prints and negatives will be stored in the project file. Digital photographs will be stored in the electronic project file. If digital photographs are downloaded from the camera in the field, they will be transferred to the in-office electronic file on a regular basis. Photographic prints or paper copies of digital images will be identified with recorded field book entry information.

7.2 Video

Video site recordings will be logged in the field logbook with the following information:

- Recorder's name;
- Project name and project number;
- Date and time;
- Description of subject of video including identification of any persons appearing in video.

If video does not have accompanying audio, record a placard of the site name, date and time and subject of video at the beginning of the video. If the video recorder has an audio recording feature, a narration of the video identifying information may be used. The video tape or digital video disk (DVD) will be labeled with the project name, project number, date, location, and subject). The original, unaltered tape shall be placed in the official files.

8.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, D0420-98R03 Guide to Site Characterization for Engineering Design and Construction Purposes.

ASTM International, D4840-99R04 Guide for Sample Chain-of-Custody Procedures.

ASTM International, D5434-03 Guide for Field Logging of Subsurface Explorations of Soil and Rock.

ASTM International, D6089-97R03E01 Guide for Documenting a Ground-Water Sampling Event.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia, www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-01-02

PROJECT FILE MANAGEMENT Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines to assure the integrity and preservation of electronic files within the Network. It also describes the manner in which electronic files are to be identified and handled in the routine entry of data, reports, proposals, etc. onto computer hard drives and tapes.

2.0 EQUIPMENT AND MATERIALS

- Project files including, but not limited to, documents, data, photographs, correspondence and maps.
- Appropriate paper document storage supplies, furniture and facilities.
- Permanent electronic file storage equipment (computer hard drives and random access memory computer disks [CD-ROMs]).

3.0 FILE SECURITY

Adequate security will be maintained for both paper and electronic files relating to each project in accordance with its corporate document security policies.

4.0 PAPER FILES

4.1 ACTIVE PROJECTS

Paper files containing documents relating to an active project will be maintained at the consultant's office. All paper files will be sorted according to type and filed in accordance with the consultant's internal project-specific paper filing system. Paper documents from field activities will be brought

from the field to the consultant's office for filing on a regular basis. All paper documents will be maintained in the active project files until final closure of the project.

4.2 CLOSED PROJECTS

Upon final closure of the project, all paper files containing documents relating to the project will be permanently archived in accordance with the consultant's internal file retention policies and client-specified file retention or archiving requirements. Discuss these procedures with the Project Manager.

5.0 ELECTRONIC FILES

5.1 ACTIVE PROJECTS

Electronic files containing documents relating to active project will be maintained at the consultant's office. All electronic files will be sorted according to type and filed in accordance with the consultant's internal electronic project filing system. Data saved electronically to field computers will be transferred to the consultant's in-office computer network on a regular basis via CD-ROMs or as attachments to electronic mail (email) transmissions. All electronic documents will be maintained in the active project files until final closure of the project.

5.2 CLOSED PROJECTS

Upon final closure of the project, all electronic files containing documents relating to the project will be permanently archived in accordance with the consultant's internal file retention policies and client-specified file retention or archiving requirements.

5.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

SOP SERIES SAS-02

FIELD MEASUREMENTS - GENERAL

STANDARD OPERATING PROCEDURE NO. SAS-02-01

EQUIPMENT CALIBRATION, OPERATION, AND MAINTENANCE Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for controls, calibration, and maintenance of measurement and testing equipment to be used for obtaining samples for chemical analyses, for measuring field parameters, and for testing various parameter/characteristics. The purpose of this SOP is to ensure the validity of field measurement data generated during field activities as required in the Work Plan or as otherwise specified.

2.0 EQUIPMENT AND MATERIALS

- Measurement and testing equipment ;
- Equipment/instrumentation-specific operation manuals;
- Equipment/instrumentation-specific cases, battery chargers, and attachments; and
- Calibration standards (e.g. standard gas(es), calibration fluids, pH standards, etc.).

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

4.1 General

Field measurements are used to verify sampling procedures, assist in sample selection, and evaluate field conditions. A variety of equipment/instrumentation may be utilized to obtain the field measurements required to satisfy and document project goals outlined in Work Plans or otherwise specified. Therefore, instrument operators must be thoroughly familiar with the operation of measuring instruments. Users will complete the appropriate training and be certified, if required, before using the instrument in the field.

All equipment/instrumentation will be uniquely and permanently identified (model/serial number, equipment inventory number, etc.). Manufacturer's guides/operation manuals will be kept with the instrument or a designated area on the Site, as appropriate. The Site Manager or designee will obtain, identify, and control all equipment/instrumentation to be used during the project.

4.2 Calibration

Measuring equipment/instrumentation must be calibrated before initial use as recommended in the manufacturer's guide/operation manual. Equipment/instrumentation shall be re-calibrated following 1) the manufacturer's recommended calibration frequency, 2) long periods between uses, 3) readings observed above or below the range of the instrument, and/or 4) signs or evidence of equipment malfunction. Daily calibration and re-calibration activities will be recorded in the field logbook and/or on the appropriate field form and will include the following information:

- Date and time of calibration or re-calibration;
- Equipment/instrumentation manufacturer, make, and model;
- Equipment/instrumentation serial or unique inventory number;
- Method of calibration (may reference procedures outlined in the guide/instrument manual);
- Calibration standard(s) used; and
- Deviations, if any, from the manufacturer's recommended procedure(s) or calibration frequency.

4.3 Operation

Manufacturer's instructions will be followed for correct method(s) of operation. Equipment malfunctions and deviations, if any, from the manufacturer's recommended method(s) of operation will be documented in the field logbook and/or on the appropriate field form. Readings obtained from each instrument shall be recorded in the field logbook or on the appropriate field form.

4.4 Maintenance

Equipment/instrumentation will be maintained in accordance with the manufacturer's recommendations. Equipment/instrumentation that malfunctions or is scheduled for routine maintenance will be clearly labeled to prevent its continued use until repairs/maintenance is completed. The Site Manager or her/his designee will be responsible for ensuring that malfunctioning equipment is identified, marked for repair, repaired either in-house or by an outside company in accordance with manufacturer guidelines, checked following repair, and returned to service. The Site Manager or her/his designee will maintain an equipment log, which contains the following:

- Equipment/instrumentation manufacturer, make, and model;
- Equipment/instrumentation serial or unique inventory number;
- Recommended calibration frequency;
- Recommended maintenance frequency, as appropriate;
- Status (in service, not in use, or out of service for repair/maintenance);
- Dates of status changes (e.g. date returned to service); and
- Inspection and maintenance/repair dates.

5.0 REFERENCE

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001

STANDARD OPERATING PROCEDURE NO. SAS-02-02

SURVEYING Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for surveying activities that will be performed by the consultant. Timeframes or budgets may not always allow for surveying by licensed surveying professionals. The consultant may need to obtain information in a timely and cost effective manner that will aid in project decisions (e.g. groundwater flow direction, hydraulic gradient, etc.). In these cases, the consultant will perform basic surveying to obtain this information. The purpose of this SOP is to outline general procedures to obtain reliable surveying data in support of project goals and decisions as required in the Work Plan or as otherwise specified.

2.0 EQUIPMENT AND MATERIALS

- Topcon Auto Level or equivalent;
- Tripod;
- Plumb line;
- Graduated surveying stick; and
- Field logbook and/or appropriate field form.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement

and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

4.1 General

Survey equipment shall be inspected prior to commence of surveying activities to ensure that all components are present and functional. Graduations on the surveying stick should be well marked. Equipment not in satisfactory condition should be removed from service and repaired or replaced, as appropriate.

Operators must be thoroughly familiar with the operation of surveying equipment. Operators should complete the appropriate training and be certified, if required, before using the equipment in the field.

4.2 Benchmark Selection

A fixed, permanent reference point is critical for tying in surveying results to known site features and reproducing surveying results in the field. The benchmark should be a unique location, preferable one that would appear on a plat of survey, that is not likely have its elevation affected by field or outside activities (e.g. flange bolt on a fire hydrant, base of a property boundary stake, corner of a loading dock, etc.). The benchmark shall be documented and clearly described in the field logbook and/or on the appropriate field form. The location of the benchmark should also be measured relative to a minimum of two other permanent site features. These measurements should also be recorded in the field logbook and/or on the appropriate field form. Typically, a licensed surveyor will establish the benchmark which will be used on the site. If the benchmark cannot be established by a licensed surveyor, make sure the Project Manager is informed.

4.3 General Procedures

Surveying will be conducted following the procedures outlined below:

1. Make a table in the field logbook or utilized the appropriate field form to record the following information:
    a. Benchmark;
    b. Assigned benchmark elevation;

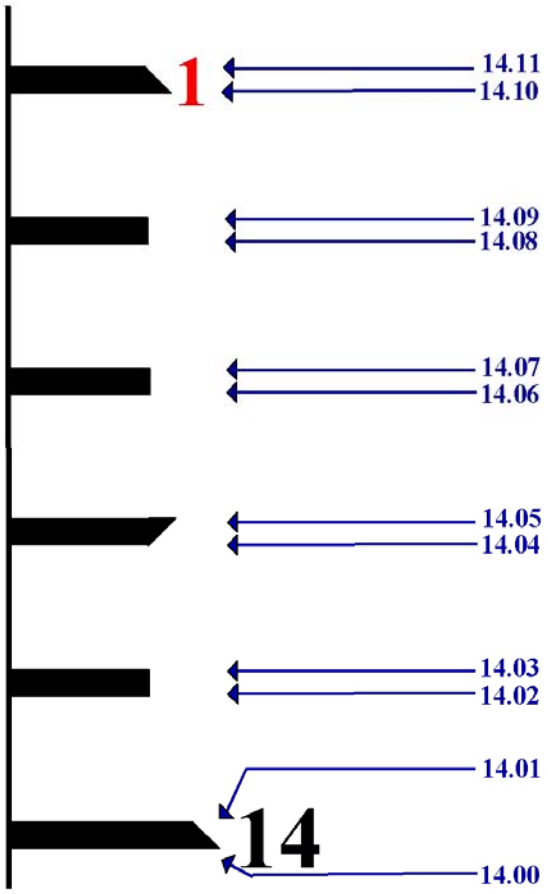
c. Instrument Height(s);
d. Temporary Benchmark(s);
e. Survey points (e.g. monitoring well top of casing, ground surface, etc.); and
f. Surveying stick graduation.

2. Locate a benchmark (BM).
3. Describe the BM in the field logbook and/or on the appropriate field form. The description must be detailed enough to allow a person unfamiliar with the Site to locate the BM.
4. Measure the location of the BM from at least two other permanent site features and record the measurements in the field logbook and/or on the appropriate field form.
5. Choose a location for the tripod that is in view of the benchmark and as many surveying points as possible.
6. Set up the tripod and attach the plumb line.
7. Adjust the tripod legs until the plumb line hangs at a 90-degree angle from the top plate of the tripod.
8. Place the Topcon Auto Level (or equivalent) on the tripod.
9. Adjust the auto level legs until the Topcon Auto Level is level as indicated by the leveling bubble (Note: The bubble should be centered in the circle).
10. Verify the auto level is level by rotating the auto level 90, 180, and 270-degrees. The bubble should be centered in the circle at all three positions. If the bubble is not centered in the circle, repeat Steps 7 through 10.
11. The surveying assistant will stand the surveying stick on the benchmark.
12. The operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level electronically or in the field logbook and/or on the appropriate field form as the back sight measurement.
13. The operator shall record Instrument Height #1 (IH_1), which is obtained by adding the surveying stick graduation to the arbitrary benchmark elevation (usually 100.00 feet), in the field logbook and/or on the appropriate field form.
14. The surveying assistant will stand the surveying stick on a surveying point.

15. The operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level in the field logbook and/or on the appropriate field form as the front sight measurement.
16. The operator shall record Survey Point #1 (SP_1) elevation, which is obtained by subtracting the surveying stick graduation from IH_1, electronically or in the field logbook and/or on the appropriate field form.
17. Repeat Steps 14 through 16 until all survey points or all survey points visible from the first instrument location have been measured.
18. Locate a Temporary Benchmark (TBM_1).
19. The surveying assistant will stand the surveying stick on TBM_1.
20. The operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level in the field logbook and/or on the surveying data form as the front sight measurement.
21. The operator shall record TBM_1 elevation, which is obtained by subtracting the surveying stick graduation from IH_1, electronically or in the field logbook and/or on the appropriate field form.
22. The operator shall relocate the instrument and repeats Steps 6 through 10. Note: During this time the surveying assistant should not remove the surveying stick from the top of TBM_1.
23. Once the instrument has been relocated and leveled, the operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level in the field logbook and/or on the surveying data form as the back sight measurement.
24. The operator shall record Instrument Height #2 (IH_2), which is obtained by adding the surveying stick graduation to the TBM_1 elevation determined in Step 21, electronically or in the field logbook and/or on the appropriate field form.
25. If all surveying points have been measured, skip to Step 36. If all surveying points have not been measured, proceed to step 26.
26. Repeat Steps 14 through 16 until all survey points or all survey points visible from the instrument location have been measured.
27. Locate another Temporary Benchmark ($TBM_{\#}$).
28. The surveying assistant will stand the surveying stick on $TBM_{\#}$.

29. The operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level in the field logbook and/or on the surveying data form as the front sight measurement.
30. The operator shall record $TBM_{\#}$ elevation, which is obtained by subtracting the surveying stick graduation from $IH_{\#}$, electronically or in the field logbook and/or on the appropriate field form.
31. The operator shall relocate the instrument and repeats Steps 6 through 10. Note: During this time the surveying assistant should not remove the surveying stick from the top of $TBM_{\#}$.
32. Once the instrument has been relocated and leveled, the operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level electronically or in the field logbook and/or on the appropriate field form as the back sight measurement.
33. The operator shall record Instrument Height # ($IH_{\#}$), which is obtained by adding the surveying stick graduation to the $TBM_{\#}$ elevation determined in Step 30, electronically or in the field logbook and/or on the appropriate field form.
34. Repeat Steps 14 through 16 until all survey points or all survey points visible from the instrument location have been measured.
35. If all surveying points have been measured, skip to Step 36. If all surveying points have not been measured, proceed to step 27.
36. The surveying assistant will stand the surveying stick on the benchmark.
37. The operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level in the field logbook and/or on the surveying data form as the front sight measurement.
38. The operator record BM elevation, which is obtained by subtracting the surveying stick graduation from $IH_{\#}$, electronically or in the field logbook and/or on the appropriate field form.
39. If the BM elevation is within 02/100 of an inch ($\pm$0.02) of the initial or assigned BM elevation, the surveying has been completed successfully. If the BM elevation is not within 02/100 of an inch ($\pm$ 0.02) of the initial or assigned BM elevation, an error was made or the tripod and/or auto level were bumped during surveying. In this case, the surveying activities were not completed successfully and must be repeated.

4.4 Reading the Surveying Stick



5.0 REFERENCE

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001

SOP SERIES SAS-03

SAMPLE COLLECTION - GENERAL

STANDARD OPERATING PROCEDURE NO. SAS-03-01

SAMPLE IDENTIFICATION, LABELING, DOCUMENTATION AND PACKING FOR TRANSPORT Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes procedures for identifying, logging, packing, preserving and transporting environmental samples for chemical or physical analysis.

2.0 EQUIPMENT AND MATERIALS

- Sample containers;
- Sample labels;
- Field logbook;
- Pens with waterproof, non-erasable ink;
- Chain-of-custody (COC) forms;
- Custody seals
- Clear plastic sealing tape;
- Coolers for transporting samples to the laboratory;
- Ice (if required)
- Gallon-size sealable plastic bags; and
- Air bills or similar transportation provider forms.

3.0 HEALTH AND SAFETY

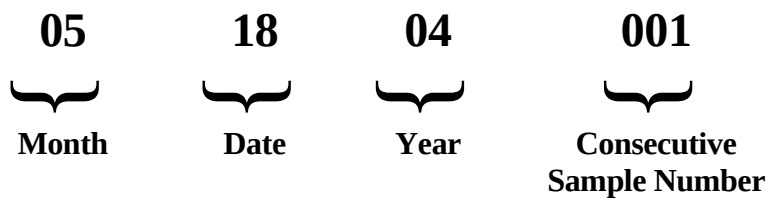
Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from

available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 SAMPLE IDENTIFICATION

A unique 9-digit identification code will be assigned to each sample retained for analysis on all United States Environmental Protection Agency (USEPA) sites and on a site-specific basis as determined by the project manager. This code will be formatted as a number series with the sample month (2-digit), date (2-digit), year (2-digit) and consecutive sample number (3-digit).

Example: The first sample for a particular phase of an investigation collected on May 18, 2004 would be identified as 051804001, as detailed below.



Consecutive sample numbers will indicate the individual sample sequence in the total set of samples collected during that phase of investigation.

Duplicate samples will be assigned a unique 9-digit identification code. Samples selected for matrix spike/matrix spike duplicates (MS/MSD) will include "MS/MSD" at the end of the unique 9-digit identification code. The unique 9-digit identification code is compatible with USEPA electronic data submittal requirements. Sample identification numbers will be used on sample labels, COC forms and other applicable sampling activity documentation.

Sample media codes will be noted on field notes and logs using the following media codes:

Sample numbering will consist of up to three components: a three-character alpha Site identification code; a four- to five-character alpha numeric sample type code; and the sample depth below ground surface (bgs, if soil) or the sample depth below top of mudline (sediment). Groundwater samples will typically not include sample depth bgs unless there are multiple intervals sampled in one open borehole. An example of a completely numbered sample, with each component identified follows.

Example: AES-SP01-(0-0.5)
Where: AES – Any Environmental Site
SP01 – Soil probe location number 1
(0-0.5) – soil sample collected 0-0.5 feet bgs

The site identification code (e.g. AES in the sample above) will remain the same for all samples collected at the Site.

The sample type code (SP01) will vary depending on sample type and location. The following are typical alpha codes to be used in the alphanumeric sample type code for samples:

- AS – air sparging sample;
- CF – confirmation soil sample;
- GP – gas probe sample;
- MW – groundwater monitoring well (if deep and shallow wells are sampled for the same location, this type code is modified to DMW (deep well) and SMW (shallow well);
- PZ – piezometer sample;
- RW – recovery well sample;
- SB – soil boring sample;
- SD – sediment sample;
- SP – soil probe sample;
- SS – surface soil sample;
- SR – source material (used if source material is known to exist);

- SV – soil vapor probe sample;
- SW – surface water sample;
- TP – test pit sample; and
- VE – vapor extraction sample.
- WC – waste characterization (may be preceded by S for solid waste or L for liquid waste).

If additional sampling type codes are required, they will be specified in the site-specific work plan.

When completing soil borings and probes, if a water sample is collected from an open boring or probe location a "w" will be attached to the end of the alpha-numeric sample type code (e.g., SB01W). The numerical portion of the sample type code will indicate the sample location (i.e., boring location 01, 02, 03, etc.).

5.0 SAMPLE LABELING

The following information will be included on each sample label: site name/client, sample number, name of sampler, sample collection date and time, depth of sample (if applicable), analyses or tests requested and preservations added. Information known before field activities (site name, analyses requested, etc.) can be preprinted on sample labels. Duplicate sample labels can be prepared when various sample aliquots must be submitted separately for individual analyses.

6.0 SAMPLE DOCUMENTATION

The following itemized list will be used as a general reference for completion of sample documentation:

- Record all pertinent sample activity in the field logbook in accordance with SOP SAS-01-01, Field Documentation and Reporting.
- Make or obtain a list of samples to be packaged and shipped that day.
- Determine number of coolers required to accommodate the day's shipment based on number of samples to be shipped, number of containers per sample and number of sample containers that will fit in each cooler.
- If samples are shipped by Federal Express or other express shipping service, complete an air bill.

- Assign chain-of-custody form to each cooler and determine which sample containers will be shipped in each cooler. (Note: More than one chain-of-custody form may be needed to accommodate number of samples to be shipped in one cooler).
- Determine which samples will be shipped under each chain-of-custody form. Each day that samples are shipped, record chain-of-custody form numbers, and air bill numbers (if used) in field logbook. Cross-reference air bill and chain-of-custody numbers.
- Complete COC forms in accordance with SOP SAS-03-02, Chain of Custody.
- Assign custody seals to each cooler and temporarily clip seals to each chain-of-custody form.
- Group paperwork associated with each cooler with a separate clip.
- Obtain necessary field team members' full signatures or initials on appropriate paperwork.

7.0 SAMPLE PACKING FOR TRANSPORT

The steps outlined below will be followed to pack the sample containers into coolers for shipment.

1. Each glass sample container will be wrapped with protective packing material.
2. Packing material will be placed in the bottom of each cooler for cushioning.
3. Sample containers will be placed inside each cooler, taking care not to overfill the cooler.
4. Ice will be double bagged sealable plastic bags and added to the cooler on top of the samples. Sample containers will be packed so that they are not in direct contact with ice. The remaining empty space in each cooler will be filled with packing material.
5. Packing material will be placed over the top of the bagged ice.
6. The chain-of-custody records will be signed, and the date and time at which the coolers are sealed for transport by a shipping company, or relinquished to a delivery service or the laboratory sample receiving department will be indicated.
7. Copies of chain-of-custody records will be separated. The original signature copies will be sealed in a large, sealable, plastic bag and taped to the inside lid of a cooler. A copy of each COC will be retained by the Site Manager.
8. If any cooler has a drain, the drain will be taped shut.
9. The lid to each cooler will be closed and latched. Custody seals will be affixed to each cooler between the lid and the body of the cooler. One custody seal will be placed on the front of the cooler, and one will

be placed on the back. Custody seals will be covered with clear plastic tape. An example of a custody seal is located in SOP SAS-03-02, Chain-of-Custody.

10. The cooler will be closed and taped shut on both ends with several revolutions of tape. Also, tape will be wrapped several times around the cooler body and the cooler lid to firmly secure the cooler lid and body together.
11. Samples will be packed and transported to the analytical laboratory within one day of collection.

8.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, D3694-96(2004) Standard Practices for Preparation of Sample Containers and for Preservation of Organic Constituents

ASTM International, D4220-95R00 Practices for Preserving and Transporting Soil Samples

ASTM International, D4840-99(2004) Standard Guide for Sampling Chain-of-Custody Procedures.

ASTM International, D6911-03 Guide for Packaging and Shipping Environmental Samples for Laboratory Analysis

International Air Transport Association (IATA), 2005, Dangerous Goods Regulations.
USEPA, 1981, *Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples*, Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-03-02

CHAIN OF CUSTODY Revision 0

1.0 PURPOSE

This Standard Operating Procedure describes procedures for preparation and use of the chain of custody (COC) form that accompanies field-collected soil, sediment, water, air or geotechnical samples. Procedures are also provided for preparation and use of custody seals for securing openings of sample containers during transport of samples to the analytical laboratory. COC forms and custody seals are used to provide documentation of sample integrity from the time of collection to time of sample receipt and acceptance by the analyzing laboratory or testing laboratory.

2.0 EQUIPMENT AND MATERIALS

- COC forms;
- Custody seals;
- Gallon-size plastic sealable bags; and
- Clear plastic packing tape.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 METHODS/PROCEDURES

4.1 Chain of Custody Form Items to Complete

Attachment A presents an example COC form. The following general information must be completed on the COC form:

- Laboratory name, address, telephone number;
- Document control number;
- Site manager name on Attention line;
- Project number;
- Site name;
- Complete field sample identification number;
- Sample collection date for soil, sediment and water samples or sample start and collection dates for ambient air monitoring samples;
- Time of sample collection for soil, sediment and water samples or sample start and collection times for air monitoring samples;
- Sample matrix (i.e. liquid, solid, or gas);
- Number of containers;
- Analysis or testing method requested;
- End pressure, Summa can identification number, and flow controller serial number for air monitoring BTEX samples and filter identification number for air monitoring PM10 samples.
- Sample preservatives used (other than ice) in Remarks column;
- Turn-around time requested (specify if turn-around time is business or calendar days) in Special Instructions box;
- Signature of person(s) conducting sampling;
- Strike line with samplers initials and the date samples are relinquished in order to complete unused portion of COC form;
- Signature of person relinquishing the sample custody (person relinquishing custody must be a sampler to ensure chain of custody is maintained);
- Signature of person transporting samples to the lab if other than sampler/relinquisher or third-party carrier;

- **DO NOT** write "FedEx" or other third-party carrier's name in the Relinquished To box. The air bill and carrier's established custody documentation procedure is used to verify custody during transportation.
- Date and time samples are relinquished;
- Custody seal identification numbers; and
- Freight bill identification number in Special Instructions box or at bottom of Remarks column (if third party shipper is used to transport).

4.2 Chain of Custody Form and Procedures

- If a sampling event requires the use of more than one shipping container (cooler for soil/sediment/water samples or box for certain air monitoring samples or soil samples for geotechnical testing) a separate COC form must be completed for each shipping container. For each container, the associated COC form must list only the samples contained in that container.
- When it is known that numerous chains of custody will be required for a project or for a single sampling event, it is acceptable to pre-type the laboratory name, address, telephone number, project number, site name, 3-letter project name abbreviation in Document Control Number area, and site manager name. These are the only information fields that may be pre-typed.
- Each COC should contain a unique document control number in the format: 3-letter project name abbreviation – identification number – 4 digit year, e.g. AES-001-2006, AES-002-2006 and so on. For each project COC identification numbers should be assigned sequentially beginning with 001 for each calendar year. (Exception: for remediation ambient air monitoring projects that span two or more calendar years, continue sequential numbering throughout the project.)
- The COC form must be completed in ink.
- Corrections must be made by drawing a single line through the data that is in error and initialing and dating at the end of the line. The use of correction fluid or tape is not allowed. Do not write over text or numbers to correct. If multiple corrections are needed, copy correct information to a new COC and destroy copy with errors.
- If the number of samples included in the shipping container is less than the number of data entry lines on the COC, draw a single diagonal line running from left down to the lower right hand corner of the field sample data area. The sampler's initials and date must appear along the line.

- Seal the completed COC form in a plastic storage bag. For cooler shipping containers, tape the bag to the inside of the cooler lid prior to sealing the cooler. For box shipping containers, insert the bagged COC form into the box prior to sealing the box.
- If samples are to be shipped by a third party carrier (e.g. Federal Express) the third party carrier does not need to sign the chain of custody. The COC form may be sealed inside the container prior to shipping. If samples are to be hand-delivered to a laboratory by someone other than the sampler/relinquisher (e.g., site construction manager or laboratory courier), the sampler/relinquisher must transfer custody by having the carrier sign in the "Received By" section of the COC form and enter the date and time of transfer. Then seal the COC form inside the container.

4.3 Custody Seal Procedures

A sample custody seal is a strip of adhesive paper used to detect unauthorized tampering with samples prior to receipt by the laboratory. Attachment A presents an example of a completed custody seal. Custody seals are pre-numbered and should be used instead of laboratory custody seals whenever possible.

- A minimum of two custody seals are used per shipping container, one on each long side of the cooler or across each opening of a box. For coolers, one of the custody seals must be placed from the lid to the side of the cooler such that it would be necessary to break the seal in order to open the shipping container. Cover each custody seal with a single piece of clear packing tape wrap it around the perimeter of the cooler. For boxes, place a custody seal across each opening of the box (top and bottom) and cover with a piece of packing tape, making sure tape is secured in such a way that it cannot easily be removed.
- The relinquisher must sign and date each custody seal in ink and include the site identification abbreviation in the custody seal number area.
- Each custody seal has a pre-printed unique six-digit identification number. This number along with the site identification abbreviation must be transferred exactly to the Custody Seal Number box on the COC. The identification number of all custody seals used in conjunction with the COC must be listed on the COC. If a custody seal other than the pre-numbered one, a unique identification number must be printed on the seal and transferred exactly to the Custody Seal Number box on the COC.

5.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

A copy of the COC forms and freight bills used in the above procedure will be transferred to the Project Manager and maintained in the project-specific file as part of the official chain of custody record.

6.0 QUALITY CONTROL AND QUALITY ASSURANCE

- Each COC will be checked for accuracy and completeness (i.e. sample list complete, sample data entered correctly etc.) by another member of the field sampling team before samples are relinquished for transport. In the event the sampler is the sole person on-site, the COC will be checked for accuracy and completeness within 24 hours of the sampling event by a member of the project team.
- Review of the COC forms and freight bills used in the above procedure will be conducted during evaluations of sampling procedures by personnel. The COC forms will also be reviewed as part of the data validation process when the laboratory returns the completed COCs following receipt and analysis of samples.

7.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM, International, 1999, D 4840-99 (2004) Standard Guide for Sample Chain-of-Custody Procedures.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

ATTACHMENT A
EXAMPLE CHAIN-OF-CUSTODY AND CUSTODY SEAL FORMS

Request for Chemical Analysis and Chain of Custody Record

Send Results to:	Laboratory:	Document Control No.:
	Address:	Lab. Reference No. or Episode N
Attention:	City/State/ZIP:	
	Telephone:	
Project Number:		Sample Type
Site Name:		Matrix

Sample Number			Sample Event		Sample Depth (in feet)		Sample Collected		Matrix			Number of Containers	Parameter/Method Code						Remarks
Group or SWMU Name	Sample Point	Sample Designator	Round	Year	From	To	Date	Time	Liquid	Solid	Gas								

Sampler *(Print Name)*:	Sampler *(signature)*:	Custody Seal Number	Special Instructions

Relinquished By *(signature)*: 1.	Date/Time	Received By *(signature)*: 1.	Date/Time	Ice Present in Container: Yes ☐ No ☐	Temperature Upon Receipt:
Relinquished By (signature): 2.	Date/Time	Received By (signature): 2.	Date/Time	Laboratory Comments:	

Signature _____

Date _____ # -112504

STANDARD OPERATING PROCEDURE NO. SAS-03-03

SAMPLE LOCATION IDENTIFICATION AND CONTROL Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the identification of sample locations and field measurements of topographic features, water levels, geophysical parameters, and physical dimensions frequently required during groundwater, hazardous waste, and related field investigation activities. The scope of such measurements depends on the purpose of the field investigation. Samples collected from each sampling location will have a unique sample identified in accordance with ENV-03-01.

All sampling locations shall be uniquely identified and depicted on an accurate drawing or a topographic or other site map, or be referenced in such a manner that their location(s) are established and reproducible. A sample location must be identified by a coordinate system or other appropriate procedures which would enable an independent investigator, to collect samples from reproducible locations. Repetitive sampling might be performed, for example, to monitor the progress of a remedial program, to check for suspected erroneous results from an initial sampling, or to check the reproducibility of results.

2.0 EQUIPMENT AND MATERIALS

- Site map;
- Surveying equipment;
- Measuring tape;
- Field notebooks/logs; and
- GPS unit.

3.0 SAMPLE LOCATION IDENTIFICATION

Locations for collection of samples are assigned alphanumeric codes which are used to coordinate laboratory data tracking and graphic depiction of sample locations on drawings and figures. Samples collected from each sampling location will have a unique sample identified in accordance with ENV-03-01. Each sample location is issued a unique numeric code that corresponds to a specific map location on a plan view of a site and vicinity. An alpha-code (letter) is used to describe the type of sampling activity performed at the specific numeric location. The following alpha codes will be used:

Air	AS	Air Sparging Point
	GP	Gas Probe
	GM	Gas Monitoring Well
	SV	Soil Vapor Probe
	VE	Soil Vapor Extraction Well
Material	AC	Asbestos Containing Material
	LS	Lead Wipe Sample
Sediment	SD	Sediment
Soil	SB	Soil Boring
	SS	Surface Soil
	TP	Test Pit
	EB	Excavation Base
	EW	Excavation Well
Water	MW	Groundwater Monitoring Well
	PZ	Piezometer
	PW	Potable Water Well
	RW	Recovery Well
	TW	Temporary Monitoring Well
	SW	Surface Water
	SG	Surface Water Staff Gauge

A typical series of alpha numeric codes for a site might include test pit locations TP01 through TP12; borings SB01, SB02, SB03; monitoring wells MW01, MW02, MW03, etc.

Each sample location will have only one alphanumeric code. A borehole drilled for the purpose of installing a monitoring well will be identified as MW01. There should not be a location SB01 for soil sample location identification and MW01 for groundwater sample location identification.

Note that soil borings performed for the purpose of collecting a groundwater grab sample (e.g. through screened auger, open borehole, Geoprobe®, Hydro-Punch®, etc.) are identified as soil borings, not monitoring wells. These types of sampling locations may be further identified on site figures with a clarifying suffix (GW), such as SB01(GW). The site map legend will explain the meaning of all symbols used to identify sampling points.

If previous work has been performed at a site, the alphanumeric code should continue with previous successive numbers. If there is any potential for conflict with existing sample number identifiers, the proposed sample number should begin with series 101, 1001, or other appropriate system. Dashes should be eliminated from sample number identifiers, such as SB101 should be used instead of SB-101.

4.0 SURVEYED LOCATIONS

Survey control should be performed following monitoring well and borehole installations by a surveyor licensed in the state of the project site. Vertical elevations to the top of each new well casing will be established within ± 0.01 foot. Ground surface elevations at each well and borehole location should be established within ± 0.01 foot. Elevations should be referenced to the North American Vertical Datum of 1988 (NAVD 88). Alternative systems may be used on a project-specific basis, with appropriate reference documentation in the master project file and final reports.

Lateral locations based on an established grid system will be determined for each sampling location. Lateral locations should be calculated to within ± 1-foot. The site map should include at minimum sampling locations, structure boundaries, property boundaries, nearby surface water, site grid system origin according

to either a state plane coordinate system or latitude and longitude, bar scale, and a north arrow. Specific state reporting and mapping requirements should be checked prior to final plan development.

In conducting vertical surveys, the following procedures should be used or should be referenced in subcontractor service agreements with licensed surveyor:

- When practical, level circuits will close on a bench mark other than starting bench mark;
- Readings should be recorded to the closest 0.01 foot using a calibrated rod;
- Foresight and backsight distances should be reasonably balanced;
- Rod levels should be used;
- No side shot should be used; and
- Benchmarks should be traceable to USGS benchmarks.

Field staff and contractors will record all field data collected during survey activities in accordance with SOP SAS-01-01 for incorporation into site data reports, maps, tables, etc.

5.0 TRIANGULATION

Triangulation shall be used if a registered surveyor is not contracted. This method encompasses distance measurement from sampling points relative to two and sometimes three known points. Distance measurements should be accurate to within ±1 foot allowing for sag in the measuring tape and other inaccuracies. Measuring to two known points is typically adequate for rough measurements made with a pocket transit and 100-foot tape; however, measuring to three known points reduces potential error. Distance measurements should be made relative to distinctive features having a probable life span in excess of 10 years. Examples include the following:

- Power pole located on north side of plant entrance #1 driveway;
- SE corner of plant building 2 located at 111 Survey Circle; or
- NW corner of retaining wall running north-south along Bass Creek.

Unacceptable triangulation points include fence posts, trees, temporary stakes or markers etc., unless these features are to be located within 15 days by survey.

When locating sampling points, decide which site features will be important to illustrate on a site map in the report. If appropriate, also locate areas of known or suspected spills and manholes which may represent migration pathways. Establish relative locations of these and other pertinent site features by triangulation.

The client should be consulted regarding the existence of plant drawings or other surveyed maps which accurately show the relative location of major site features. The field notebook should record information describing the drawing (e.g., who it was prepared by, date, drawing number, etc.) and describe the points on the drawing being used for triangulation purposes.

If only one site feature is convenient for triangulation, the remaining two reference points can be established by running a line toward a more distant site feature, which can be easily located later, and the recorded distance from a defined point along that line.

6.0 GLOBAL POSITIONING SYSTEM (GPS)

Global Positioning System (GPS) is an appropriate method to determine the location of site investigation features in limited circumstances, and is solely at the discretion of the project manager.

There are significant accuracy limitations with GPS which limits the effectiveness of this technology in the role of sample location. For sites where accuracy less than ± 10 feet is acceptable, or surveying is impractical, GPS is a suitable sample location method. GPS is not suitable for sites requiring a higher degree of accuracy. However, the recording of GPS coordinates is encouraged for all sites where monitoring wells or other permanent features may be obscured by snow, vegetation, or other obstructions. In such cases, GPS may assist in locating the monitoring well, etc. despite the accuracy limitations.

7.0 REFERENCES

ASTM International, 2002, D5906-02 Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia, www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

Zilkoski, David B., J.H. Richards, and G.M. Young , 1992, Results of the General Adjustment of the North American Vertical Datum of 1988, American Congress on Surveying and Mapping, Surveying and Land Information Systems, Vol. 52, No. 3, 1992, pp.133-149.

SOP SERIES SAS-04
SAMPLING QUALITY CONTROL

STANDARD OPERATING PROCEDURE NO. SAS-04-01

DATA QUALITY GENERAL CONSIDERATIONS Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes general guidelines that are to be used in conjunction with the USEPA mandatory data quality objectives (DQO) process. Guidelines are intended to assist with planning and conducting quality sampling operations in the field.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials will vary based on the type of data and method of data collection. In general, the following equipment and materials shall be utilized to assist with the collection and recording of quality data:

- Site map(s);
- Field logbook and/or appropriate field forms;
- Method-specific, laboratory-provide containers for the collection of samples for chemical analysis;
- Chain of custody (COC) forms;
- Measuring tape(s), Global Position System (GPS), or other equipment necessary to document sample location; and
- Camera.

3.0 HEALTH AND SAFETY WARNING

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement

and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 SAMPLING CONSIDERATIONS

There are two categories of sampling collection activities. The categories include 1) collection of screening data with definitive confirmation and 2) collection of definitive data. The decision making process in each category incorporates a wide range of analytical methods and provides quality analytical data.

Screening data provides a quick, preliminary assessment of site contamination that involves rapid, non-rigorous methods of sample preparation and less precise analytical methodologies. Preliminary assessments of types and levels of contaminants can be made quickly which allows for the greatest amount of data with the least expenditure of time and money. Screening data generally produces data that can be identified and quantified, but may not be relatively precise. A minimum of 10 percent of the screening data must be confirmed using definitive data. Without sufficient confirmation data, screening data will not be recognized as quality data.

Data that is generated by stringent analytical methods (e.g. approved USEPA methods) is defined as definitive data. Whether generated on or off-site, the quality assurance/quality control (QA/QC) protocol of the analytical methods must be achieved. Analytical and total measurement of error must be calculated for the data to be considered definitive. Definitive data is generally analyte-specific and can be confirmed by subsequent analysis (e.g. duplicate, matrix spike/matrix spike duplicate, etc.). Printed or electronic data, spectra, and chromatographs are typically provided as backup information.

Several factors must be considered prior to data collection to ensure the data obtained meets the DQOs and is appropriately addressed and incorporated into procedures outlined the Site-Specific Work and/or Field Sampling Plan (FSP) or otherwise specified in activity- or task-specific SOPs:

- Representative Sampling Sites – Selection of representative sampling sites is dependent on the type of investigation undertaken.

- Analytical Methods/Parameters – The analytical methods/parameters shall be dictated by the constituents of potential concern (COPCs), sample media, potential range of chemical concentrations, site conditions, and field investigator's knowledge.
- Sample Collection Method – The sample collection method to be used shall be dictated by the investigation, analytical methods/parameters, and category of data desired (screening data with definitive confirmation or definitive data).
- Sampling Equipment – The sampling equipment shall be dictated by the investigation, category of data desired (screening data with definitive confirmation or definitive data), analytical method, sampling method, and the potential for the equipment materials to affect analytical results (e.g. cross-contamination potential, sorption potential, etc.).

5.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2000, D6568 Standard Guide for Planning, Carrying Out, and Reporting Traceable chemical Analyses of Water Samples.

ASTM International, 2004, D7069-04 Guide for Field Quality Assurance in a Ground-water Sampling Event.

USEPA. 1994a. Evaluation of Sampling and Field-Filtration Methods for the Analysis of Trace Metals in Ground Water s. September 1994, EPA/600/SR-94/119.

USEPA, 1995. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria levels. April 1995, EPA/621/R-95/114.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-04-02

DATA QUALITY OBJECTIVES Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for determining Data Quality Objectives (DQOs). The USEPA has established a mandatory DQO process for sites to ensure that all data is scientifically valid. The DQO process also establishes protocols to support decision making which includes defining the type, number, and quality of the environmental data to be collected.

2.0 DATA QUALITY OBJECTIVES PROCESS

The DQO process is a series of seven steps that facilitate the planning of environmental data collection activities. DQOs are qualitative and quantitative statements developed from the DQO process. The DQO process helps investigators ensure that data collected are of the right type, quantity, and quality needed to support environmental decisions.

The following are the seven steps of the DQO process (USEPA 2006):

1. State the problem.
2. Identify the goal of the study.
3. Identify information inputs.
4. Define the boundaries of the study.
5. Develop the analytic approach.
6. Specify performance or acceptance criteria.
7. Develop the plan for obtaining data.

This DQO process shall define qualitative and quantitative criteria for determining when, where, and how many samples (measurements) to collect for a desired level of confidence. The DQO process shall be employed during the planning stages of any field investigation activities that include analytical data collection. This information along with sampling procedures, analytical procedures, and appropriate quality

assurance/quality control (QA/QC) procedures shall be documented in the Quality Assurance Project Plan (QAPP), Field Sampling Plan and SOPs, and/or Site-Specific Work Plan(s).

3.0 DATA QUALITY OBJECTIVE (DQO) LEVELS

Data collected and analyzed from a field investigation is categorized by five DQO levels. Each of these levels is determined by the types of technology and documentation used, and the analytical degree of sophistication. These DQO levels are numbered I through V, with Level I being the lowest quality data and Level V the highest. These DQO levels will be used when determining the appropriate data collection methods for achieving the goals of the field investigation.

3.1 DQO Level I

DQO Level I data typically are field screening data collected in real-time using portable instruments, e.g. photoionization detector (PID). This DQO level is normally used to aid in sample point selection and to differentiate highly impacted samples from low-level impacts. Level I analyses are used for qualitative data collection only, and results cannot be considered quantitative. Instrument calibration provides the quality control component for Level I data.

3.2 DQO Level II

DQO Level II data is typically characterized by field analysis of samples using portable instruments that can be used on-site, e.g. portable gas chromatograph (GC) instrument. This level is considered semi-quantitative due to lack of supporting QA/QC documentation. Instrument calibration provides the quality control component for Level II data.

3.3 DQO Level III

DQO Level III data is data generated in an analytical laboratory using USEPA and other recognized standard methods with rigorous QA/QC protocols. The analytical laboratory can be either an on-site mobile laboratory or a remote laboratory. Level III data is considered quantitative; it provides identification and quantification of chemicals in environmental samples. This data may be used for evaluating compliance of sample results

relative to environmental standards, in risk assessment studies, and may be compared to results of other samples collected at a similar DQO level.

3.4 DQO Level IV

DQO Level IV data is the same as DQO Level III with the addition of rigorous documentation including raw data from the analytical laboratory instruments. Level IV analytical data is quantitative and defensible. Superfund investigations normally require DQO Level IV for data used in conducting formal human health risk assessment studies. Standard USEPA-designated field procedures are required on all investigations requiring DQO Level IV quality data. Any deviations from these methods shall be documented in the field logbook and/or on the appropriate field form, or in the approved Site-Specific Work and/or Sampling Plan. Field personnel involved in data collection shall be aware that such deviations in the fieldwork may reduce the DQO level of the data, with a subsequent reduction in data usability.

3.5 DQO Level V

DQO Level V data include deviations from the standard suites of parameters normally analyzed under the USEPA protocols. DQO Level V procedures are by definition non-standard and, therefore, they are not discussed in detail. DQO Level V procedures generally require pre-approval before use and shall be addressed in Site-Specific Work and/or FSP(s), as appropriate.

4.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, D7069-04 Guide for Field Quality Assurance in a Ground-water Sampling Event.

USEPA, 1990, Quality Assurance/Quality Control Guidance for Removal Activities, Sampling QA/QC Plan and Data Validation Procedures, Interim Final, EPA/540/G-90/004.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, 2002a, Quality Management Plan for the Superfund Division, Region 5, Chicago, Illinois.

USEPA, 2002b, Guidance for Quality Assurance Project Plans, EPA QA/G-5, EPA/240/R-02/009.

USEPA, 2006, Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4, EPA/240/B-06/001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-04-03

QUALITY CONTROL SAMPLES Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the collection of quality control (QC) samples. QC samples are utilized to evaluate field and laboratory quality control procedures and the precision, accuracy, representativeness and comparability of data obtained during investigative activities.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials for the collection and analysis for quality control samples shall be identical to those used for the collection and analysis of the sample of similar media and collection method.

3.0 HEALTH AND SAFETY WARNING

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 QUALITY CONTROL SAMPLES

QC samples include field duplicate samples, matrix spike (MS) and matrix spike duplicate (MSD) samples, trip blanks, and field/equipment blanks.

4.1 Field Duplicate Samples

Duplicate samples are collected from various media to evaluate the representativeness and comparability of data obtained during investigative activities. These samples shall be collected at the same time, using the same procedures, the same equipment, and in the same types of containers as the original sample. They shall also be preserved in the same manner and submitted for the same analyses as the requested analytes. The minimum/required frequency of duplicate sample collection for each sample media shall be specified in the Quality Assurance Project Plan (QAPP), Field Sampling Plan (FSP), and/or Site-Specific Work and/or Sampling Plan(s). If the frequency of collection is in conflict between the above mentioned documents, the Site-Specific Work shall take precedence. The evaluation of these samples is described in the QAPP.

4.2 Matrix Spike and Matrix Spike Duplicate Samples

MS/MSD samples are collected from various media to evaluate the precision and accuracy of laboratory procedures. As with field duplicate samples, MS/MSD samples shall be collected at the same time, using the same procedures, the same equipment, and in the same types of containers as the original sample. They shall also be preserved in the same manner and submitted for the same analyses as the requested analytes. The minimum/required frequency of MS/MSD sample collection for each sample media shall be specified in the QAPP, FSP, and/or Site-Specific Work and/or Sampling Plan(s). If the frequency of collection is in conflict between the above mentioned documents, the Site-Specific Work shall take precedence. The evaluation of these samples is described in the (QAPP).

4.3 Trip Blanks

Trip blanks are used as control or external quality assurance/quality control (QA/QC) samples to detect contamination that may be introduced in the field, in transit to or from the sampling site, or in bottle preparation, sample log-in, or sample storage sites within the laboratory. Trip blanks will also reflect contamination that may occur during the analytical process. Trip blanks are samples of reagent free water, properly preserved, which are prepared in a controlled environment prior to field mobilization. These samples are prepared by the analytical laboratory. The trip blanks are kept with the laboratory provided containers through the sampling process and returned to the laboratory with the other aqueous samples for VOC analysis. Trip blanks must be used for samples intended for VOC analysis and are preserved and analyzed for

VOCs only. One trip blank will accompany each cooler containing aqueous samples for VOC analysis or as specified in the QAPP, FSP, and/or Site-Specific Work and/or Sampling Plan(s). If the frequency of collection is in conflict between the above mentioned documents, the Site-Specific Work shall take precedence. The evaluation of these samples is described in the QAPP.

4.4 Field/Equipment Blanks

Field/equipment blanks are used to determine 1) if non-disposable equipment decontamination procedures are being carried out properly and there is no "carryover" from one sample to another and 2) ensure that disposable equipment is free of measurable concentrations of constituents of potential concern. Field/equipment blank shall be collected by pouring distilled or ultrapure/DI water onto or into the sampling equipment and direct filling the appropriate sample containers with the DI water from the sampling equipment. Field blank will be handled and treated in the same manner as all samples collected unless noted otherwise below. Field/equipment blanks are always collected after sampling equipment has been decontaminated and may be performed prior to collecting the first sample, after collecting highly impacted samples, and/or at the conclusion of sampling. The minimum/required frequency of field/equipment blanks for each sample media shall be specified in the QAPP, FSP, and/or Site-Specific Work and/or Sampling Plan(s). If the frequency of collection is in conflict between the above-mentioned documents, the Site-Specific Work shall take precedence. The evaluation of these samples is described in the QAPP.

5.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, 1990, Quality Assurance/Quality Control Guidance for Removal Activities, Sampling QA/QC Plan and Data Validation Procedures, Interim Final, EPA/540/G-90/004.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, 2002a, Quality Management Plan for the Superfund Division, Region 5, Chicago, Illinois.

USEPA, 2002b, Guidance for Quality Assurance Project Plans, EPA QA/G-5/ EPA/240/R-02/009.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-04-04

EQUIPMENT DECONTAMINATION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for decontamination of equipment prior to its 1) initial use onsite 2) reuse at another sampling interval or location, and 3) demobilization from Site as specified in the Site-Specific Work Plan or as otherwise specified. Personnel decontamination is described in the site-specific Health and Safety Plan (HASP).

2.0 EQUIPMENT AND MATERIALS

Decontamination equipment and materials may vary based on the size or type of equipment, but generally include the following:

- Decontamination detergents (e.g. Alconox);
- Tap water;
- Deionized, distilled and organic-free water;
- Acid solution (optional);
- Approved cleaning solvent (e.g. isopropanol, hexane, Stoddard) (optional and/or site-specific);
- Metal scrapers;
- Brushes;
- Buckets;
- Steam cleaner or high-pressure, hot water washer;
- Racks, normally metal (not wood) to hold miscellaneous equipment;
- Buckets, 55-gallon drums, or other approved storage containers;
- Plastic sheeting;
- Utility pump (optional);
- Paper towels;
- Personal protective equipment; and

- Logbook and/or appropriate field form.

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific HASP based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

4.1 General Requirements

All expected types and levels of contamination shall be discussed during field activity planning and a decontamination plan sufficiently scoped within the Site-Specific Work Plan. Until proven otherwise, all personnel and equipment exiting the area of potential contamination/work zone will be assumed to be contaminated. Personnel involved in decontamination efforts shall be equipped with the same personal protective equipment as those conducting the field activity until a lower level of risk can be confirmed.

Decontamination procedures may be subject to federal, state, local, and/or the client's regulations. All regulatory requirements shall be satisfied, but the procedures adopted shall be no less rigorous than those presented in this SOP.

Climatic conditions anticipated during decontamination activities may impact the implementation of the procedures describe in this SOP. Special facilities or equipment may be needed to compensate for weather conditions (e.g. temporary, heated structures for winter work). In addition, it may be necessary to establish special work conditions during periods of high heat or cold stress.

4.2 Preparation

4.2.1 Site Selection

The equipment decontamination facility or area shall be located in an area where contaminants can be controlled and at the boundary of a "clean zone" or "cold zone". The location shall also be selected to prevent equipment from being exposed to additional or other contamination. When Site layout and size allow, a formal "contamination reduction zone" or "warm zone" shall be established in which decontamination efforts will be conducted. This area shall be conspicuously marked as "off-limits" to all personnel not involved with the decontamination process.

The equipment decontamination facility or area shall also be located where decontamination fluids and materials can be contained and easily discarded or discharged into controlled areas of waste. This facility or area shall have adequate space for the storage of unused and used storage containers, until such time as they can be relocated or disposed of.

4.2.2 Decontamination Pad

Some Site may have an existing decontamination pad. If a decontamination pad has been previously constructed, it shall be evaluated for logistics capabilities, such as water supply, electrical power, by-product handling capabilities, and cleanliness. An existing decontamination pad shall be used or modified to the extent practical. If a decontamination pad is not present or the existing pad cannot be used or modified for use, a pad consisting of a sturdy base, lined with plastic sheeting of high-density polyethylene with four raised sides and a sump for collection of fluids will be constructed unless otherwise specified by the Site-Specific Work Plan. Some field activities, which consist of hand sampling or other small equipment, may not require a decontamination pad. In these cases, buckets, small wash tubs, or small pools may be sufficient for equipment decontamination.

4.2.3 Water Supply

Large volumes of water, often exceeding 1,000 gallons per day, may be required for decontamination activities, especially for drill rigs and other large equipment. The water used for decontamination must be clean, potable water. In most cases, municipal water supplies are adequate. Private potable water supplies shall be evaluated on a case-by-case basis prior to use.

4.2.4 Cleaning Equipment and Supplies

A portable steam cleaner or high-pressure hot water washer is normally required to clean contaminated heavy machinery (e.g. drill rig, backhoe, etc.) as well as materials and associated tools. Most steam cleaners and washers are commercially available for both portable generators or supplied AC power. Site logistical considerations may dictate the type of equipment required. Typical steam cleaners/washers operated on relatively low water consumption rates (2 to 6 gallons per minute) and can be used in conjunction with other cleaning fluids mixed with the water. High-pressure steam is preferred to high-pressure water because of steam's ability to volatilize organics and to remove oil and grease from equipment. Since units tend to malfunction easily and are susceptible to frequent maintenance and repair (especially under frequent use and freezing conditions), a second or back-up unit should be available onsite or arranged for with a nearby vendor to the extent practical, for longer duration field activities.

Garden sprayers may be used for final rinsing or cleaning. However, these sprayers shall be limited to use with small hand tools and sampling equipment. Since these sprayers tend to malfunction or break down easily, a second or backup sprayer shall be maintained onsite.

Metal scrapers and brushes shall be used to physically remove heavy mud, dust, etc. from equipment prior to and during the equipment rinses. Scrapers and brushes are relatively inexpensive and shall be replaced as necessary to support cleaning activities.

Decontamination solutions may consist of the following:

- Laboratory detergent shall be a standard brand of laboratory detergent such as Alconox® or Liquinox®;
- Nitric acid solution (10 percent) will be made from reagent-grade nitric acid and deionized water;
- Cleaning solvent;
- Potable water;
- Deionized water;
- Distilled water; and
- Organic-free water.

The use of cleaning solvents shall be carefully considered prior to use with respect to safety, handling and disposal, and potential impact to analytical results and the environment.

Potable, deionized, distilled, and organic-free water should contain no heavy metals or other inorganic compounds (i.e., at or above analytical detection limits) as defined by a standard Inductively Coupled Argon Plasma Spectrophotometer (ICP) scan and no pesticides, herbicides, extractable organic compounds, and less than 5 µg/l of purgeable organic compounds as measured by a low-level GC/MS scan. The level of QA/QC required during the project to verify and document the purity of the water and the number of rinsate blanks required to verify and document the effectiveness of decontamination procedures shall be based on data quality and project objectives as specified by the Site-Specific Work and/or Quality Assurance Project Plan (QAPP). The use of non-potable or untreated potable water supply for decontamination is not acceptable.

4.3 Equipment and Vehicle Decontamination Procedures

4.3.1 General Procedures

The following procedures are presented as general guidelines and shall be followed unless otherwise required by the Site-Specific Work Plan or otherwise specified:

1. Physical removal of particles;
2. Steam or water wash with potable water to remove particles;
3. Rinse critical pieces of equipment with an approved cleaning solvent or nitric acid solution (optional and/or site-specific);

4. Steam or water wash with a mixture of detergent and potable water;
5. Steam or water rinse with potable water; and
6. Air dry.

4.3.2 Special Case – Drilling Equipment

During decontamination of drilling equipment and accessories, clean auger flights, drill rods, and drill bits as well as all couplings and threads. Generally, decontamination can be limited to the back portion of the drill rig, drill rig tires, drill rig mast, and parts that come in direct contact with samples or casings or drilling equipment placed into or over the borehole.

Some items of drilling equipment cannot typically be decontaminated. These items include wood materials (e.g. planks), porous hoses, engine filters, etc. These items shall not be removed from site until ready to dispose of in an appropriate manner.

Other drilling equipment that requires extensive decontamination is water or grout pumps. Circulating and flushing with a potable water and detergent solution followed by potable may be sufficient to clean them. However, if high or unknown contaminant concentrations or visible product is known to exist, then disassembly and thorough cleaning of internal parts shall be required before removal of the equipment from the Site.

4.4 Sampling Equipment Decontamination Procedures

4.4.1 General Procedures

Sampling equipment shall be decontaminated prior to its 1) initial use onsite 2) reuse at another sampling interval or location, and 3) demobilization from Site using the following procedure as general guidelines unless otherwise required by the Site-Specific Work Plan or otherwise specified:

1. Physical removal of particles;
2. Rinse with an approved cleaning solvent or nitric acid solution (optional and/or site-specific);
3. Wash and scrub with a detergent and potable water solution;
4. Rinse with potable water;

5. Rinse with high-grade water (deionized, distilled, or organic-free);
6. Air dry; and
7. Wrap in aluminum foil, shiny side out, for transport.

4.4.2 Special Cases

Steel tapes, water and interface probes, transducers, and thermometers, shall be cleaned with a detergent solution and rinsed with high-grade water. Water quality meters shall be rinsed with high-grade water.

Pumps with internal components that contact a water sample (e.g., bladder pump) shall be deconned by pumping a detergent solution (minimum two gallons) followed by potable water rinse (minimum two gallons) and a high-grade water rinse (minimum two gallons). If field conditions (e.g., the presence of product) indicate circulating and flushing a pump with a detergent solution followed by potable water is not an adequate field decontamination procedure, the pump shall be disassembled and internal parts thoroughly cleaned with a detergent solution followed by potable water rinse and a high-grade water rinse.

4.5 Well Material Decontamination Procedures

Well construction materials, including end cap, screen, and riser pipe, whether polyvinyl chloride (PVC), stainless steel, or other material shall be cleaned with a steam cleaner or high-pressure hot water washer before it is installed in the borehole. Well construction materials shall be handled while wearing latex, nitrile, or equivalent gloves.

4.6 Equipment Segregating and Labeling

Decontaminated equipment shall be stored separating from contaminated equipment in a manner that prevents the recontamination of "clean" equipment. Equipment that is cleaned utilizing these procedures shall receive a final decontamination process at the completion of field activities and will be tagged, labeled, or marked with the date that the equipment was cleaned.

4.7 Disposal Practices

4.7.1 General Disposal Requirements

Disposal practices shall be in accordance with the procedures specified in the Site-Specific Work Plan. Decontamination derived waste shall be contained, consolidated, and disposed shall be conducted to prevent the spread of contaminants offsite or to "clean" locations onsite and in a manner consistent with the acceptable disposal practices for the type and concentration of wastes that may be contained in the decontamination derived waste. Contaminated equipment or solutions shall not be discarded in any manner that may lead to the contamination of the environment by the migration of hazardous constituents from the Site by air, surface, or subsurface transport mechanisms.

4.7.2 Onsite Storage, Treatment, and Disposal

On controlled, secured facilities, most decontamination derived waste shall remain onsite pending waste characterization and disposal. The decontamination derived waste shall be labeled and stored in a manner that does not pose a threat to contamination of personnel or areas to be sampled or a threat of release to the environment. Liquids and solids shall be containerized separately in approved storage containers. Each storage container shall be labeled with the following:

- Contents (e.g. decontamination fluids);
- Incompatibilities (if applicable);
- Accumulation date; and
- Contact person and phone number.

In some cases, an onsite treatment system is available for certain types of decontamination derived waste. Treatment of decontaminated derived wastes shall be performed in accordance with any applicable permit requirements and federal, state, and local laws and regulations.

In some cases, certain materials that are not contaminated or contain very low levels of contamination may be disposed of onsite. Such materials may include may include drill cuttings, wash water, drilling fluids, and water removed during the purging or sampling of wells. The low level of contamination (concentrations

below applicable cleanup objectives) shall be confirmed prior to onsite disposal. Onsite disposal shall comply with federal, state, and local laws and regulations.

4.7.3 Offsite Disposal

In most cases, decontamination derived waste cannot be disposed of or treated onsite. Decontaminated derived waste shall be properly characterized prior to shipment to a licensed and approved treatment, storage, and disposal facility. Decontamination fluids discharged to sanitary and/or storm sewers shall be properly permitted prior to discharge. Offsite disposal shall comply with federal, state, and local laws and regulations.

5.0 DOCUMENTATION

Decontamination activities, including deviations for general procedures, shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP ENV-01-01 or as required by the Site-Specific Work.

6.0 REFERENCES

ASTM International, D5088-02 Practices for Decontamination of Field Equipment Used at Waste Sites.

USEPA, Region IV, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

SOP SERIES SAS-05
SUBSURFACE INVESTIGATION METHODS

STANDARD OPERATING PROCEDURE NO. SAS-05-01

SUBSURFACE EXPLORATION CLEARANCE Revision 0

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to ensure intrusive site activities are conducted with the knowledge and approval of property owners, utility providers, and governmental agencies, as appropriate, in a manner that minimizes potential exposure to subsurface hazards and damage to subsurface utilities. Clearance of intrusive activity areas must be obtained from appropriate authorities and site operators. This clearance comes in the form of 1) permission to enter a property, 2) ensuring subsurface conditions will not be encountered that endanger the safety of site personnel, subcontractors, and authorized visitors, and 3) demarcation of subsurface utilities/structures.

2.0 HEALTH AND SAFETY WARNING

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

3.0 SITE ACCESS AND ENTRY

Access to properties subject to activities conducted under the contracted scope of services/work order is the responsibility of the client as set forth in the environmental engineering and consulting services agreement. The client will give reasonable access to client-owned properties for performance of services. If the client

does not own or operate the property, it will secure an access agreement or other authorization for consultant access to the site that will address the terms of access as well as any access restrictions.

Site entrance procedures are as follows:

- The client will be advised of the date and time of site entrance and the purpose of the entrance.
- In addition, if the site is not owned by the client, the owner of the property will be advised of the date and time of site entrance and the purpose of the entrance.
- Entrance to the site shall be through the main gate or other entrance specified by the client or owner.
- If a site contact is present at the site, the consultant will introduce herself/himself and provide the site contact with a business card. The consultant shall also identify other personnel who are or will be on-site and explain their functions.
- The consultant will complete any general sign-in procedures required for site entrance, unless otherwise instructed by the client or property owner.
- If a liability waiver is presented that is not pre-agreed to by the consulting company and the client or owner, the consultant will call her/his Project Manager for instructions.
- If entry is refused, the consultant will leave the site entrance and call her/his Project Manager for instructions.
- The time of site entrance, or refusal of entrance will be included in the field logbook entry for the day.

4.0 SITE CLEARANCE

Site clearance is required prior to commencement of any investigation or remediation activities. Three categories of site clearance are required:

1. Property boundary identification,
2. Utility clearance, and
3. Clearance of any on-site subsurface obstructions, hazards or protected structures identified by the client or property owner.

4.1 Property Boundary Identification

The first step in site clearance is to demarcate the property boundaries. A client- or property owner-provided plat of survey will be used if available. If no current plat of survey is available, the client or property owner may be asked to have a licensed surveyor conduct a survey and mark the property boundaries or the consultant may hire a surveyor to conduct the survey on behalf of the client. All property boundaries should be fully known and marked prior to commencement of any site investigation activities. If an investigation location appears to be outside of the property boundaries that encompass the area to which access has been granted, the Project Manager shall be consulted prior to commencement of any activity at that location.

4.2 Utility Clearance

Written clearance of all underground utilities (private, commercial, and public) must be obtained prior to commencing intrusive site activities (e.g. soil borings, GeoProbe advancement, test pit or trench excavation). Utility clearance is vital for safe operations and provides notification to utility companies of intrusive work being conducted in the vicinity of underground lines and structures. The utility clearance process is initiated by calling a state- or city-specific one-call utility clearance hotline. One-call center information may be obtained by calling "811" or visiting http://www.call811.com/state-specific.aspx. Generally, utility clearance must be requested at least 48 hours in advance of the commencement of intrusive activities. In some states, including Illinois, utility clearance is the responsibility of the contractor performing the intrusive work (e.g. drilling subcontractor or excavation company) rather than the contracting environmental consultant.

Assemble the following information to make the call or provide this information to the subcontractor:

- Name, address and phone number of person making request;
- Type and extent (size of excavation) of work being performed;
- Start date and time of excavation;
- Address, including street, number, city, and county (township range, section and quarter section information may also be required);
- Nearest crossroad; and
- General legal description, if available.

The following table lists the one-call-center contact information for the Midwest.

	One Call System Name	Non-Emergency	Emergency	Website
Illinois (except City of Chicago)	J.U.L.I.E. Joint Utility Locating Information for Excavators	(800) 892-0123	- - -	http://www.illinois1call.com
City of Chicago	DIGGER	(312) 744-7000	- - -	http://www.cityofchicago.org
Indiana	I.U.P.P.S. Indiana Underground Plant Protection Service	(800) 382-5544	- - -	http://www.iupps.org
Iowa	Iowa One Call	(800) 292-8989	(800) 292-8989	http://www.iowaonecall.com
Kansas	Kansas One Call	(800) 344-7233	- - -	http://kansasonecall.com
Michigan	MISS DIG System Inc.	(800) 482-7171	- - -	http://www.missdig.org/MissDig/
Missouri	Missouri One Call System	(800) 344-7483	- - -	http://www.mo1call.com
Wisconsin	DIGGER	(800) 242-8511	(800) 500-9592	http://www.diggershotline.com

Utility location agencies may only mark-out utilities on public right-of-ways adjacent to the property under investigation and sewer and water departments may not be included in the locating services provided by the one-call centers. Request additional information from any utility companies or public utilities departments not included in the one-call locating services. It may be advisable at some properties to hire a private utility locating contractor to do additional on-site clearance prior to commencement of intrusive activities. Consult with the Project Manager about conducting additional locating activities if the information provided by the one-call center is not complete with respect to what is known about possible underground utilities at the site.

Do not proceed with any intrusive activities until all utility clearances and mark-outs have been performed by the locating services or participating utility companies. Do not proceed without verification from the subcontractor that the utility clearance has been performed if it was the subcontractor's responsibility to request the utility locating service. Prior to start of intrusive activities, walk the site and surrounding public right-of-way with the subcontractor locating any utility markers and discuss procedures for avoiding marked utilities during the site investigation. If at any time, a potential hazard exists at a proposed investigation

location that cannot be resolved with available information and utility location markings, contact the Project Manager for instructions.

4.3 On-Site Subsurface Obstructions, Hazards and Protected Structures Clearance

The property owner (client or third party) or a designated representative shall also be contacted prior to commencement of any intrusive activities to obtain additional information regarding on-site subsurface obstructions, hazards or protected structures and clearance to conduct the activities in pre-determined locations on the site. If possible, as part of the investigation planning activities, obtain architectural or engineering drawings of the site that include building layouts and locations of subsurface utilities and structures. Schedule an on-site meeting prior to commencement of activities to review locations of proposed locations for intrusive activities. Request that the owner or his authorized representative mark or flag the locations of any known subsurface obstruction, hazard or structure that must not be damaged. In some cases, it may be appropriate to make a site visit prior to the on-site review meeting to mark out proposed subsurface investigation locations for approval by the owner or his representative. During the review meeting, if verbal approval is given to proceed, make an entry in the field logbook including the date, time and person granting approval along with details of the approval given. Record any refusals of permission to perform intrusive activities in the same manner. Include detailed information regarding the reason for the refusal in the field logbook.

If permission for any proposed intrusive activities is refused by the property owner or his representative, inform the Project Manager. If the investigation location approval meeting is performed on a day scheduled for investigation activity, and any locations are not authorized by the owner or his representative, contact the site manager immediately for instructions. Do not proceed with any intrusive activity in the non-authorized locations unless subsequent approval is forthcoming, and do so only upon receiving approval to proceed from the owner/representative and the site Project Manager. Make a detailed record of the refusal and subsequent resolution in the field logbook.

On vacant or undeveloped sites, or sites located in remote areas, on-site client/owner approval of investigation areas may not be practical. In such situations, prior approval of investigation areas may be obtained from the client or owner by means of a site investigation map that includes investigation locations (boreholes, test pit

or trench locations, monitoring wells, etc.). Site features, boundary lines, and any known subsurface utilities or structures shall also be included on the site investigation map to provide the reviewer with adequate information to determine if any subsurface hazards exist in the vicinity of any of the proposed intrusive activities.

5.0 REFERENCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001

USEPA, Region IV, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Enforcement and Investigations Branch, SESD, Athens, Georgia

STANDARD OPERATING PROCEDURE NO. SAS-05-02

FIELD LOGGING AND CLASSIFICATION OF SOIL AND ROCKS Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for logging and classifying soil samples and rock cores during subsurface explorations as described in the Site-Specific Work Plan, or as otherwise specified, for the purposes of characterizing subsurface geologic conditions at a Site.

2.0 EQUIPMENT AND MATERIALS

General:

- Ruler or tape measure in 0.01-foot increments;
- Field logbook and field boring log forms;
- Pen(s) with waterproof, non-erasable ink;
- Camera;
- 5-gallon bucket and wire or nylon brushes, decontamination water, laboratory grade detergent (Alconox or similar), and paper towels;
- Aluminum foil or roll-plastic; and
- Personnel protective equipment, as appropriate, including nitrile gloves for handling impacted soil samples.

Soil Logging:

- Large sharp stainless-steel knife;
- Slim stainless-steel spatula or carpenter's 5-in-1 tool;
- Color chart;
- Comparative charts; and
- Pocket penetrometer.

Rock Coring and Logging:

- Core box(es);
- Hand lens; and
- Comparative charts.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 GENERAL PROCEDURES

Geologic logging and material classification shall be conducted only by a trained logging technician (e.g. geologist, hydrogeologist, engineer, or environmental scientist). Field data and observations associated with field logging and material classification shall be documented during logging and for all drilling and sampling activities in accordance with SOP ENV-01-01, Field Documentation and Reporting, if not otherwise specified in this SOP. All field drilling activities should be recorded in a field logbook and/or on a field boring log form. In addition, tools and equipment used while logging boreholes shall be decontaminated between boring/probe locations and prior to each sampling event in accordance with the Quality Assurance Project Plan (QAPP).

5.0 LOGGING AND DOCUMENTATION PROCEDURES

The logging technician shall record all pertinent drilling information in the field logbook and/or on the field boring log form (Attachment A). At a minimum, the following technical information with respect to pre-sampling, drilling operations and observations, and sample recovery loss shall be recorded, if applicable:

- Project name and number;
- Location (well or boring/probe number) or other sample station identification, including a rough sketch;
- Name of the logging technician overseeing the drilling operations;
- Drill rig manufacturer and model;
- Drilling company name and city and state of origin;
- Driller and assistant(s) names;
- Drilling method(s) and fluids used to drill the borehole;
- Drilling fluid manufacturer;
- Drilling fluid gain or loss;
- Depth of drilling fluid loss;
- Water source (e.g. fire hydrant, faucet, municipality, etc.);
- Borehole diameter;
- Borehole start time and date;
- Borehole completion time and date;
- Sample type (e.g. split spoon, macrocore, etc.);
- Hammer weight/drop and blow counts;
- Sample recovery/loss and explanation of loss, if known;
- Drilling rates when applicable to lithology classification;
- Description of soil and/or rock classification and lithology;
- Lithologic changes and boundaries;
- Depth to water (first encountered [during drilling] and stabilized [upon completion of drilling]);
- Total borehole depth;
- Evidence of impact (e.g. staining, odors, free-phase product, etc.);
- Well materials, construction, and placement information (e.g. casing type and diameter, screen type and diameter, etc.);
- Sample identifications and depths for chemical and geotechnical samples;
- A description of any tests conducted in the borehole; and
- Problems with the drill rig or drilling process.

When rock coring is performed, the following information shall also be recorded:

- Top and bottom of cored interval;
- Core length;
- Coring rate in minutes per foot;
- Core breakage due to discontinuities (e.g. natural fractures versus coring-induced breaks);
- Total core breakage; and
- Number of breaks per foot.

6.0 SOIL SAMPLE CLASSIFICATION AND DESCRIPTIONS

6.1 Description of Hierarchy

The required order of terms is as follows:

1. Depth measured in tenths of a foot;
2. Soil color;
3. Major soil type (e.g. CLAY). This descriptor can include the secondary soil constituent as a modifier (e.g. silty CLAY);
4. Unified Soils Classification System (USCS) Group Symbol in parentheses (e.g. ML);
5. Evidence of environmental impacts, if encountered (e.g. free-phase product, staining, sheen, etc.);
6. Other soil components of the sample listed with the appropriate percent descriptor (i.e. “with”, “some” or “trace.”);
7. Consistency, relative density or degree of cementation;
8. Moisture and plasticity, if relevant; and
9. Miscellaneous (e.g. condition of sample, deposition, fractures, seams, bedding dip, bedding features, fossils, oxidation, drilling rate data when applicable for sample classification, etc.).

6.2 Color

The color descriptions will be consistent with the Munsell Soil Color Chart, Geological Society of America (GSA) Rock Color Chart, or as required by the Work Plan or otherwise specified. Write the Munsell color name with the Munsell color identification number in parenthesis following the color name. The major color

is listed first with any accessory color(s) thereafter (e.g. clay, yellowish gray (5Y 7/2) with pale green (5G 7/2) mottles). If descriptors are used for other soil components, the color designation follows each descriptor.

6.3 Soil Types

Soil descriptions and classification shall be conducted in accordance with the USCS (ASTM D2488-06). The order and presentation of the primary textural classification terms is as follows:

1. Major soil type (e.g. CLAY). This descriptor can include the secondary soil constituent as a modifier (gravelly, sandy, silty, or clayey). Nouns are unabbreviated (e.g. CLAY); "TOPSOIL" is an adequate single term for the naturally occurring organic soil found at the ground surface. In urban areas, "FILL" is used to denote previously disturbed soil, followed by a description of the major and minor soil components (e.g. "FILL, silty clay with some fine sand"). USCS Group Symbol follows the major soil component in parentheses.
2. Other soil components of the sample are listed in descending order of percentage using adjectives "with", "some" and "trace."
3. Using the Wentworth Scale in Attachment E, add size, sorting or angularity modifiers to granular material descriptions as appropriate.

6.4 Consistency and Relative Density

The relative density of cohesionless soils and the consistency of cohesive soils should be included in visual classifications. Attachments B and C can be used in describing the consistency of cohesive soils and the relative density of cohesionless soils, respectively.

A pocket penetrometer will be used to measure consistency of cohesive soils with the result recorded on the field boring log form. Attachment B includes information for determining soil consistency from penetrometer measurements.

6.4 Moisture Content

Moisture Content – Criteria for describing moisture content of soils are described in Attachment D.

6.5 Miscellaneous Descriptions

1. Structure – Some soils possess structural features (e.g. fissures, slickensides, or lenses) that if present, should be described.
2. Accessories or Inclusions – Elements such as rock fragments, fine roots, or nodules are included in the soil description following all other modifiers for the major components of the soil matrix. Any mineralogical or other significant components should be described, as well as man-made or apparently foreign constituents that indicate the presence and possible source of fill material.
3. Environmental Impacts – If monitoring instruments or visual observations indicate the potential presence of environmental impacts, it will be noted in detail. Additional information for describing specific types of impacts may be found in the Work Plan.

To provide consistency in logging soils, tables with additional guidelines for soil description are included in Attachment E.

7.0 ROCK CLASSIFICATION

7.1 Lithology and Texture

The logging technician should describe the lithology of the rock and its mineral composition. The geological name, such as granite, basalt, or sandstone, usually describes the rock's origin. The stratigraphic unit should be identified and assigned the local geological name, if appropriate. Stratigraphic age or period should be identified, if possible. Modifiers will be included to describe the rock texture, including grain size, sorting, packing, cementation, etc. (e.g. interlocking, cemented, or laminated-foliated).

7.2 Color

The color descriptions will be consistent with the Munsell Soil Color Chart, Geological Society of America (GSA) Rock Color Chart, or as required by the Work Plan or otherwise specified. Write the Munsell color name with the Munsell color identification number in parenthesis following the color name. The major color is listed first with any accessory colors thereafter. If secondary or tertiary descriptors are used, the color designation follows each descriptor.

7.3 Hardness

Terms used to describe hardness are described below. One common method to determine hardness is the Mohs Scale of Hardness, which is defined as follows:

Descriptive Term	Defining Characteristics
Very Hard	• Cannot be scratched with a knife. • Does not leave a groove on the rock surface when scratched.
Hard	• Difficult to scratch with a knife. • Leaves a faint groove with sharp edges.
Medium	• Can be scratched with a knife. • Leaves a well-defined groove with sharp edges.
Soft	• Easily scratched with a knife. • Leaves a deep groove with broken edges.
Very Soft	• Can be scratched with a fingernail.

7.4 Weathering

Terms used to describe weathering are described below (ASTM D 5434-03):

Descriptive Term	Defining Characteristics
Fresh	• Rock is unstained. • May be fractured, but discontinuities are not stained.
Slightly	• Rock is unstained. • Discontinuities show some staining on the surface, but discoloration does not penetrate rock mass.
Moderate	• Discontinuous surfaces are stained. • Discoloration may extend into rock mass along discontinuous surfaces.
High	• Individual rock fragments are thoroughly stained and can be crushed with pressure of a hammer. • Discontinuous surfaces are thoroughly stained and may crumble.
Severe	• Rock appears to consist of gravel-sized fragments in “soil” matrix. • Individual fragments are thoroughly discolored and can be broken with fingers.

7.5 Rock Matrix Descriptions

Grain size is a term that describes the fabric of the rock matrix. It is usually described as fine-grained, medium-grained or coarse-grained. The modified Wentworth scale should be used or as required by the Work Plan or otherwise specified.

A description of bedding (after Ingram, 1954) or fracture joint spacing should be provided according to the following:

Spacing	Bedding	Joints/Fractures
< 1 inch	Very thin	Very close
1 – 4 inches	Thin	Close
4 inches to 1 foot	Medium	Moderately close
1 foot to 4.5 feet	Thick	Wide
> 4.5 feet	Very Thick	Very Wide

Discontinuity descriptors are terms that describe number, depth, and type of natural discontinuities. They also describe density, orientation, staining, planarity, alteration, joint or fractural fillings and structural features.

8.0 ROCK CORE HANDLING

The following guidelines shall be followed for rock core handling:

1. Core samples must be placed into core boxes in the sequence of recovery, with the top of the core in the upper left corner of the box.
2. At the bottom of each core run, spacer blocks must be placed to separate the runs. The spacer should be indelibly labeled with the drilling depth to the bottom of the core run regardless of how much core was actually recovered from the run.
3. Spacer blocks should be placed in the core box and labeled appropriately to indicate zones of core loss, if known. Where core samples are removed for laboratory testing, blocks equal to the core length removed should be placed in the box. Note: If wooden core boxes are used, spacer blocks should be nailed securely in place.

4. The core boxes for each boring should be consecutively numbered from the top of the boring to the bottom.
5. The core boxes containing recovered rock cores should be photographed. One core box should be photographed at a time with the box lid framed in the picture to include information printed on the inside of the lid. Be sure to include a legible scale in the picture. Photographs are taken in the field most easily and efficiently with natural light and while the core is fresh.
6. When transporting a boxed core, the box should be moved only if the lid is closed and secured with tape or nails.

9.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2007, D653-07b Terminology Relating to Soil, Rock, and Contained Fluids.

ASTM International, 1999, D1586-99 Standard Method for Penetration Test and Split-Barrel Sampling of Soils.

ASTM International, 2006, D2488-06 Practice for Description and Identification of Soils (Visual-Manual Procedure).

ASTM International, 2001, D4083-89R01E01 Practice for Description of Frozen Soils (Visual-Manual Procedure).

ASTM International, 2007, D4543-07 Practice for Preparing Rock Core Specimens and Determining Dimensional and Shape Tolerances.

ASTM International, 2002, D5079-02 (2006) Practice for Preserving and Transporting Rock Core Samples.

ASTM International, 2003, D5434-03 Guide for Field Logging of Subsurface Explorations of Soil and Rock.

ASTM International, 2000, D5715-00 (2006) Test Methods for Estimating the Degree of Humification of Peat and Other Organic Soils (Visual/Manual Method).

ASTM International, 2004, D6236-98 (2004) Guide for Coring and Logging Cement- or Lime-Stabilized Soil.

ASTM International, 2004, D7099-04 Terminology Relating to Frozen Soil and Rock.

Johnson, R.B., and J.V. DeGraff, 1988, Principles of Engineering Geology, John Wiley and Sons, New York.

U.S. Army Corps of Engineers, 2001, Engineering Manual EM1110-1-1804 - Engineering and Design - Geotechnical Investigations, January 1.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

Wentworth, C.R., 1922, A scale of grade and class terms for clastic sediments, Journal of Geology, 30: 377-392.

ATTACHMENT A
DRILLING LOG

Drilling Log

	Project Name	Project No.	Boring/Monitoring Well Number
	Site-Specific Coordinates	Ground Elevation	Page 1 of 1
	Total Depth (feet) / Hole Size (inches)	Driller (s)	
Drilling Rig		Drilling Company	
Date / To	Logged By:	Reviewed by:	Approved by:

Elevation (feet)	Depth (feet)	Description	Graphic Log	SAMPLING: Sample Type	Sample Interval	Blow Counts per 0.5'	N Value	Sample Recovery/Length (feet)	Penetro-meter (TSF)	PID Reading (PPM)	Remarks (▽ Depth to water while drilling; ▼ Depth to water after drilling)
	1										
	2										
	3										
	4										
	5										
	6										
	7										
	8										
	9										
	10										
	11										
	12										
	13										

ENVIRONMENTAL LOG COPY OF OSI 2003.GPJ BURNS_MO.GDT 8/30/07

ATTACHMENT B
CONSISTENCY OF COHESIVE SOILS

Author: T. Gilles **Q2R & Approval By:** C. Barry **Q3R & Approval By:** M. Kelley

CONSISTENCY OF COHESIVE SOILS

Consistency	Rule-of-Thumb	Blows Per Foot[1] (N value)[2]	Penetrometer (tons/ft^2)
Very Soft	Core (height = twice diameter) sags under own weight	0 – 1	0.0-0.25
Soft	Can be easily pinched in two between thumb and forefinger	2 – 4	0.26-0.49
Firm (Medium Stiff)	Can be imprinted easily with fingers	5 – 8	0.5-0.99
Stiff	Can be imprinted with considerable pressure from fingers	9 – 15	1.0-1.99
Very Stiff	Barely can be imprinted by pressure from fingers	16 – 30	2.0-3.99
Hard	Cannot be imprinted by fingers	> 30	4.0+

Notes:
1) Blows as measure with a 2-inch outer diameter (OD), 1 3/8-inch inner diameter (ID) sampler driven 1 foot by a 140-pound hammer falling 30 inches. See Standard Methods for Penetration Test and Split-Barrel Sampling of Soils, ASTM D1586-99.
2) N value is the sum of the blows from 6 inches to 12 inches and from 12 inches to 18 inches in the 2-foot sample.

ATTACHMENT C
RELATIVE DENSITY OF COHESIONLESS SOILS

Author: T. Gilles **Q2R & Approval By:** C. Barry **Q3R & Approval By:** M. Kelley

RELATIVE DENSITY OF COHESIONLESS SOILS

Consistency	Rule-of-Thumb	Blows Per Foot (N value)[2]
Very Loose	Easily penetrated with a ½-inch diameter steel rod pushed by hand	0 - 4
Loose	Easily penetrated with a ½-inch diameter steel rod pushed by hand	4 - 10
Medium Dense	Easily penetrated with a ½-inch diameter steel rod driven with a 5-pound hammer	11 - 30
Dense	Penetrated a foot with a ½-inch diameter steel rod driven with a 5-pound hammer	31 - 50
Very Dense	Penetrated only a few inches with a ½-inch diameter steel rod driven with a 5-pound hammer	> 50

Notes:
1) Blows as measure with a 2-inch outer diameter (OD), 1 3/8-inch inner diameter (ID) sampler driven 1 foot by a 140-pound hammer falling 30 inches. See Standard Methods for Penetration Test and Split-Barrel Sampling of Soils, ASTM D1586-99.
2) N value is the sum of the blows from 6 inches to 12 inches and from 12 inches to 18 inches in the 2-foot sample.

ATTACHMENT D
CRITERIA FOR ESTIMATING MOISTURE CONTENT OF SOILS

CRITERIA FOR ESTIMATING MOSITURE CONTENT OF SOILS

Adapted from USACE EM 1110-1-1804 and ASTM D 2488-06

Term	Description of Relative Moisture
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, no visible water
Wet	Fine grained: well above optimum water content Coarse grained: visible free water
Saturated	Water is dripping from sample, usually encountered below water table

ATTACHMENT E
STANDARD SOIL DESCRIPTORS

Author: T. Gilles **Q2R & Approval By:** C. Barry **Q3R & Approval By:** M. Kelley

STANDARD SOIL DESCRIPTORS

Grain Size Terminology		
Soil Type		**Diameter**
Boulders		12-inches or greater
Cobbles		3- to 12 inches
Gravel	Coarse	0.75-inch to 3 inches
	Fine	0.19-inch to 0.75-inch
Sand	Very Coarse	1 mm to 2 mm
	Coarse	0.5 mm to 1 mm
	Medium	0.25 mm to 0.5 mm
	Fine	0.06 mm to 0.25 mm
Silt		0.004 mm to 0.06 mm
Clay		Less than 0.004 mm

Notes:
1) mm = millimeter
2) Based on Wentworth Grain Size Scale for Sediment (Wentworth 1922).
3) This terminology can also be used to describe clast size in rock cores.

Estimated Plasticity for Silt and Clay Content		
Thread Diameter (inches)	**Plasticity Index (PI)**	**Identification**
1/4	0	Silt
1/8	5 – 10	Clayey Silt
1/16	10 – 20	Clay and Silt
1/32	20 – 40	Silty Clay
1/64	40	Clay

Relative Proportions of Components	
Descriptive Term	**Percent**
Trace	1 – 10
Little	11 – 20
Some	21 – 30
And	30 – 50

Adapted from ASTM D2488-06

STANDARD DESCRIPTORS – VISUAL OBSERVATIONS OF NAPL

Descriptive Term	Definition
No Visible Evidence	No visible evidence of oil on soil or sediment sample
Sheen	Any visible sheen in the water on soil or sediment particles or the core
Staining	Visible brown or black staining in soil or sediment; can be visible as mottling or in bands; typically associated with fine-grained soil or sediment
Coating	Visible brown or black oil coating soil or sediment particles; typically associated with coarse-grained soil or sediment such as coarse sand, gravels, and cobbles.
Oil Wetted	Visible brown or black oil wetting the soil or sediment sample; oil appears as a liquid and is not held by soil or sediment grains

STANDARD OPERATING PROCEDURE NO. SAS-05-03

WELL INSTALLATION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the installation of monitoring wells, observation wells, and recovery/injection wells as described in the Site-Specific Work Plan, or as otherwise specified. Monitoring and observations wells are installed to 1) determine depth to groundwater and monitor fluctuations in groundwater elevation, 2) determine and monitor the depth and thickness of free-phase products (if present), 3) obtain groundwater and/or free-phase product samples for laboratory analysis, and 4) facilitate aquifer characterization. Recovery wells are installed to conduct testing and operation of systems for groundwater pumping, free-phase product recovery, and aquifer injection.

2.0 EQUIPMENT AND MATERIALS

Field personnel shall use the well construction equipment and materials required by the Site- Specific Work Plan, or as otherwise specified.

3.0 HEALTH AND SAFTEY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

4.1 General requirements

Well installation procedures should meet regulatory agency requirements. In addition, licensing and/or certification of the driller may be required. A trained supervising technician (e.g. geologist, hydrogeologist, engineer, or environmental scientist) should be present during well installation to document the subsurface stratigraphy and construction details for each well.

The well designs should meet two basic criteria: 1) groundwater and/or other fluids (e.g. free-phase product) must move freely into the well, and 2) vertical migration of surface water or undesired groundwater to the well intake zone must, to the extent possible, be eliminated. In addition to these criteria, factors that influence the location of wells should be considered and include the following:

- Project objectives of the Site-Specific Work Plan;
- Data Quality Objectives outlined in the Quality Assurance Project Plan (QAPP);
- Location of facilities and/or source areas to be monitored;
- Groundwater gradient;
- Location of aboveground and underground utilities and manmade features; and
- Accessibility to desired well location sites.

4.2 Well Installation Materials Selection

Materials used in the construction of wells must remain essentially chemically inert with respect to free-phase products and dissolved contaminants in the groundwater for the duration of the investigation period remedial action.

The most commonly used well construction materials are PVC and stainless steel. PVC is the least expensive and easiest material to use. It is generally believed that PVC does not decompose in contact with groundwater containing low concentrations of organics. Stainless steel is chemically inert, provides greater structural strength, and its use may be advantageous for large-diameter wells or groundwater containing high concentrations of organics or free-phase products. Teflon casing is chemically inert but is very expensive.

Well casing and screen are available in threaded or unthreaded sections and typically in lengths of 5, 10, and 20 feet. Threaded pipe joints may be wrapped with Teflon tape to facilitate joining and to improve the seal. Sections of casing and screen should be assembled onsite to allow inspection immediately before installation. No solvents or adhesive compounds should be used on the threaded PVC or Teflon pipe.

4.3 Well Types and Construction Specifications

4.3.1 Monitoring and Observation Wells

Monitoring and observation wells construction should be performed as outlined in the Site-Specific Work Plan or as otherwise specified. In general, the design of the wells consists of a section of slotted well casing or well screen connected to a riser pipe that extends above the ground surface. Typically, a gravel or sand filter pack is placed in the annular space between the screen and the borehole wall. A 3-foot seal composed of hydrated bentonite pellets/chips is placed on top of the filter pack. The remaining height of annulus is sealed and/or grouted to the surface with a cement, bentonite/cement, or high solid bentonite grout; this annular space will be at least 3-feet in height. A lockable protective casing is constructed over the stick-up portion of the wells. Borehole diameters will be chosen in accordance with state regulations and SSWP specification and will meet the following minimum conditions:

- The diameter of the borehole shall be at least 4 inches greater than the inside diameter of the well casing, unless hollow stem augers are utilized.
- The inside diameter of hollow stem augers should generally be at least 2-¼ inches greater than the inside diameter of the well casing and screen.
- These annular clearances facilitate the placement of the filter pack and grout around the outside of the well screen and casing.

The screens for water table observation wells, typically 10 to 15 feet long, are installed with the center of the screen set at the level of the water table to monitor seasonal fluctuation of the water table. Monitoring screens for wells constructed below the water table, typically 5 feet long, are installed at the chosen monitoring elevation as specified in SSWPs. This SOP discusses stick-up well construction; however, flush-mount well construction may also be used as outlined in the Site-Specific Work Plan or otherwise specified.

4.3.2 Recovery/Injection Wells

Construction specifications for recovery/injection wells can vary based several factors including, but not limited, to 1) the type(s) of recovery/injection to be performed, 2) engineering evaluation objectives, 3) data quality objectives, and 3) site geology. Recovery/injection wells should be constructed as outlined in the Site-Specific Work Plan, or otherwise specified.

4.4 Borehole Advancement

4.4.1 General

Boreholes used to install wells should be drilled with the following objectives:

- To provide geological data on subsurface conditions, namely stratigraphy, occurrence of groundwater, and depth to bedrock;
- To obtain representative disturbed or undisturbed samples for identification and laboratory testing; and
- To install wells.

Prior to drilling, the following steps must be taken:

- Obtain permits from appropriate local, state, and/or federal agencies. If there is a fee for permits, drilling subcontractors usually include this as part of their fee.
- Notify (verbally or in writing) the appropriate local, state, and/or federal authorities, as appropriate, in advance of the date that drilling and installation is scheduled to begin;
- Perform a subsurface utility clearance, as outlined in SOP ENV-05-01, at all planned drilling locations;
- Prepare and implement field health and safety procedures as outlined in the HASP(s); and
- Make provisions for containment, storage, and disposal of all cuttings, drilling fluids, discharge water, and other refuse generated during well installation. Note: Permitting and waste characterization may be necessary prior to disposal activities.

4.4.2 Selection of Drilling Method

Drilling methods should be selected based on the following factors:

- The expected nature of the subsurface materials to be encountered in the boring;

- Site accessibility, considering the size, clearance, and mobility of the drilling equipment;
- Availability of drilling water and the acceptability of drilling fluids (e.g., bentonite based drilling mud) in the well;
- Diameter and depth of the well desired, including consideration of the need to set casing to prevent commingling of different transmissive zones; and
- The nature and effects of contaminants expected during the drilling.

5.0 MONITORING AND OBSERVATION WELL INSTALLATION

5.1 Well Components

Typical well components in general order of placement are as followings:

1. Surface casing (if used);
2. Well casing;
3. Screen(s);
4. Filter pack (gravel or sand pack)
5. Filter pack seal (fine sand; and bentonite seal when grout is placed as the annular seal);
6. Annular seal (bentonite chips or grout);
7. Well head protector casing; and
8. Well head apron and guard posts.

Surface casing, if needed, should be installed during borehole advancement for sealing the ground surface and subsurface transmissive zones not desired to be intercepted by the well from the borehole. Surface casing may also be needed to provide lateral support for loose unconsolidated formations that may slough into or collapse around the borehole during drilling or well installation. Casing may be extended in a telescopic fashion to permit casing through intermittent transmissive zones at greater depths to limit casing size and cost requirements.

The well casing is the primary conduit to the desired borehole interval to be monitored. It serves to seal off other stratigraphic zones from the groundwater inside the well and provides unobstructed access to the well screens. The well casing extends from the top of the well screen to either above or flush with the ground

surface. It is typically a single-walled pipe, flush-threaded, of the smallest diameter to facilitate sampling equipment and to support its own weight during installation.

Screens are perforated or slotted sections of casing typically of the same size and material as the well casing. The purpose of the well screen is to allow water and/or other fluids (i.e., product) to enter the well easily while preventing entry of large amounts of sediment. The slot size of the well screen is usually determined based on selection of the filter pack material. Both are commonly related to the grain size analysis of the formation material. Methods of determining appropriate screen slot size are listed in the EPA Manual of Water Well Construction Practices (USEPA 1976). Typically, 10-slot (0.010 inch slot width) or 20-slot (0.020 inch slot width) screens are used. The length of the screen depends on the sampling objective, water level fluctuations, product thickness, and thickness of the transmissive zone of the formation.

A filter pack consisting of clean silica sand or pea gravel is placed in the annular space extending to at least 2 feet above the top of the screen. Filter pack grain size, sand or pea gravel, is determined based on the well screen slot size selected and the nature of the surrounding native material. The filter pack will stabilize the aquifer formation, minimize the entry of fine-grained material into the screen, permit use of screens with different sizes of slot, and will increase the effective well diameter and water collection zone. A filter pack seal, consisting of at least 2 feet of fine sand, will be placed on top of the filter pack to prevent the intrusion of overlying grout material.

For wells with that utilize grout as an annular space seal, an additional filter pack seal, consisting of bentonite pellets or chips, should be installed above the fine-sand filter pack seal to prevent the intrusion of overlying grout material into the filter pack. The bentonite pellets or chips should be slowly poured from the top of the borehole to prevent bridging. At least 3 feet of bentonite seal should be placed on top of the fine-sand filter-pack seal. If the bentonite seal is above the saturated zone, the bentonite pellets or chips should be hydrated with distilled water before grouting the remaining annular space. The source and volume of water used must be recorded in field notes. The hydrated pellets or chips should be allowed to set for a minimum of 15 minutes. Bentonite chips are preferred over pellets or balls when the seal is below the water table because the chips hydrate less rapidly and bridging is less common.

The annular space above the bentonite seal should be grouted with cement high-solids bentonite, bentonite/cement grout, or bentonite chips, up to 30 inches below the ground surface and shall be at least 2 feet in thickness. The primary purpose of grouting is to minimize the vertical migration of water to the groundwater intake zone and to increase the integrity of the well casing.

A 30 inch concrete plug should be installed above the annular grout, when the surface seal is less than 5-feet in depth. The concrete plug is used to set the protective well cover and to prevent frost heave of the concrete pad or apron. The concrete apron should be at least 3.5 inches thick, and it should be sloped to allow water drainage away from the well.

A protective cover with a locking cap should be installed after the well has been set. This cover will protect the exposed well casing from damage and will provide security against tampering with the well. The protective cover typically consists of a steel pipe or box around the well casing. The protective cover is set at least 5 feet into the surface seal and may be reduce to 2 feet if a flush-mount well cover is placed or a shorter protective cover is required to ensure well construction space for a 2 foot minimum annular space seal.. Weep holes (approximately ¼-inch diameter) may be drilled into the base of the protective cover above the concrete apron to allow drainage. Alternatively, one to two inches of fine-grained sand may be placed at the base of the flush-mounted protective cover to facilitate drainage.

Well-head aprons and guard posts, when used, provide additional surface protection to the well and are generally used for wells in high traffic areas or where a more permanent structure is desired.

5.2 Installation Procedures

The decision to install a well at a particular location is often decided in the field upon completion of the boring and subsurface sampling. If the borehole diameter is not sufficient to install a well, either the borehole should be reamed using a larger diameter auger or a new borehole should be drilled. The new borehole should be at least 5 feet away from the initial boring. The initial soil boring should be abandoned according to the procedures outlined in SOP ENV-05-05. If a well is not installed, the boring should be abandoned in accordance with SOP ENV-05-05.

Over-drilling generally should not be conducted to provide room for a well sump or additional filter pack material at the bottom of the borehole beneath the well casing. However, for wash rotary boreholes drilled in soft or highly plastic sediments, loose cuttings may fall to the borehole bottom after backwashing. In this case, it may be necessary to install a 2-foot layer of sand or gravel at the bottom of the boring to provide a firm base on which to set the well assembly to limit settling of the well casing and screen under its own weight.

For mud rotary boreholes, excess drilling fluids should be flushed from the borehole before installing the filter pack and grout seal. This can be accomplished by one or both of the following means:

- Flush the well using the drilling equipment by pumping clean water down the drill pipe without circulating the returned fluid. This should be accomplished at low pump pressure and with care to avoid scouring or fracturing of the formations. The source and volume of water added to the well must be recorded in field notes.
- Insert casing and screens with a backwash valve on the bottom end, and then flush the borehole via the well casing at low pressures. The backwash valve not only provides an outlet for flushing, but also provides pressure relief so the screens are not damaged by the backwash fluid pressures.

The latter method should be conducted only if it is determined that the former is not possible, or if the drilling fluid must remain in place in order to install the filter pack.

Connect the screen and well casing while wearing latex gloves. Insert and lower the screen and well casing into the borehole in 10-foot increments. Hand-tighten connections to prevent them from leaking or becoming loose. The final section of pipe should be measured and field cut, if necessary, before connecting to allow for a stick-up of at least 2 feet. The cut end should be rasped and/or sanded smooth, taking care not to let fillings of casing material cling to the inside.

Backwash the boring, if necessary, and pour in sand or gravel to seat and support the casing and screen. Based on boring and casing diameters, determine volume of filter pack material required to place the filter approximately 2 feet above the top of the screens. Install filter pack using the following methods, as appropriate.

- Slowly pour filter material down annulus, being careful to evenly distribute the material around the casing and to avoid the material becoming packed between the sidewall and casing. Use a small-diameter pipe to dislodge packed material and to ensure adequate height and settlement of the filter pack.

- Pour filter material down tremie pipe placed between boring sidewall and casing. In this method, clean potable or distilled water should be poured in along with the sand or gravel to prevent packing within the tremie. The source and volume of water added must be recorded in field notes. The bottom of the tremie should be kept above the filter material top by at least 5 feet to permit the filter material to evenly fall around the screens. Pack the material with the tremie pipe to ensure adequate height and settlement of the filter pack.

Pour bentonite pellets or chips down the annulus on top of the filter pack. The bentonite should be placed rapidly to prevent swelling and bridging around the casing when it hydrates. The bentonite should be allowed to hydrate for at least 15 minutes before grouting.

The remaining annulus should be sealed by pumping grout via a tremie pipe from the bottom of the annular space of the borehole until the grout returns to the surface displacing all remaining drilling fluid and formation water. The bottom of the tremie pipe should not be placed within 4 feet of the bentonite seal. Grouting mixture and technique should be in accordance with Site-Specific Work Plan requirements, or as otherwise specified. Grout will typically settle 1 to 2 feet. Remove excess grout to allow 30 inches of annular space for the concrete plug or native material.

After the grout has stiffened sufficiently, install the concrete plug up to the ground surface. Set the protective cover, if possible, such that at least 2 feet of its length is embedded in the concrete below the ground surface. It should also be set such that it is not more than approximately 30 to 36 inches above the level where the sampling personnel must stand. A concrete pad approximately 3 feet in diameter and 3.5 inches thick should be formed around the base of the protective cover. The concrete pad should be sloped away from the protective cover to allow flow away from the well. Weep holes should be drilled through the protective cover nominally 1 inch above the top of the concrete apron.

The protective casing should be marked with identifying decals. A locking device should be installed to prevent unauthorized entry or vandalism of the well. The top of the well casing should be notched with a file to provide a reference point in which to measure water and/or product levels. The elevation of the top of the well casing (reference point) and ground surface at the well should be surveyed relative to a benchmark. The location of the well should also be surveyed in reference to the site coordinate system as required by the Site-Specific Work Plan, or as otherwise specified.

Develop well within 24 to 72 hours following well installation according to the well development procedures outlined in ENV-05-04.

6.0 DOCUMENTATION

Documentation of well installation should be the responsibility of the supervising field technician. A well completion report should be prepared after the well is installed. The Illinois Department of Public Health Well Completion Report is provided as a well completion report example in Attachment A. If the work is performed in a different state, the relevant forms must be obtained.

The drilling and well installation activities should be recorded in the field logbook and/or on the appropriate field forms. The following information should be recorded during and upon completions of every well installation:

- Project name and number;
- Well location identification;
- Date of installation and time completed;
- Drilling method, crew names, and rig identification;
- Drilling depths;
- Generalized subsurface stratigraphy;
- Total length of casing and screens;
- Depth to and length of screened intervals;
- Depth to top of filter pack;

- Depth to top of bentonite seal;
- Depth to top of grout;
- Depth of surface casing (if applicable);
- Elevation of top of well casing and ground surface; and
- Name of supervising field technician.

The driller should also prepare any state-required well completion forms in accordance with state regulatory requirements.

7.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2004, D5092-04 Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers.

ASTM International, 2005, D6001-05 Guide for Direct-Push Ground Water Sampling for Environmental Site Characterization.

ASTM International, 2004, D6724-04 Guide for Installation of Direct-Push Ground Water Monitoring Wells.

ASTM International, 2004, D67-25-04 Practice for Direct-Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers.

USEPA, 1976, Manual of Water Well Construction Practices, EPA/570/9-75/001.

USEPA, 2002, Ecological Assessment Standard Operating Procedures and Quality Assurance Manual, SESD, Region 4, Ecological Assessment Branch, Athens, Georgia.

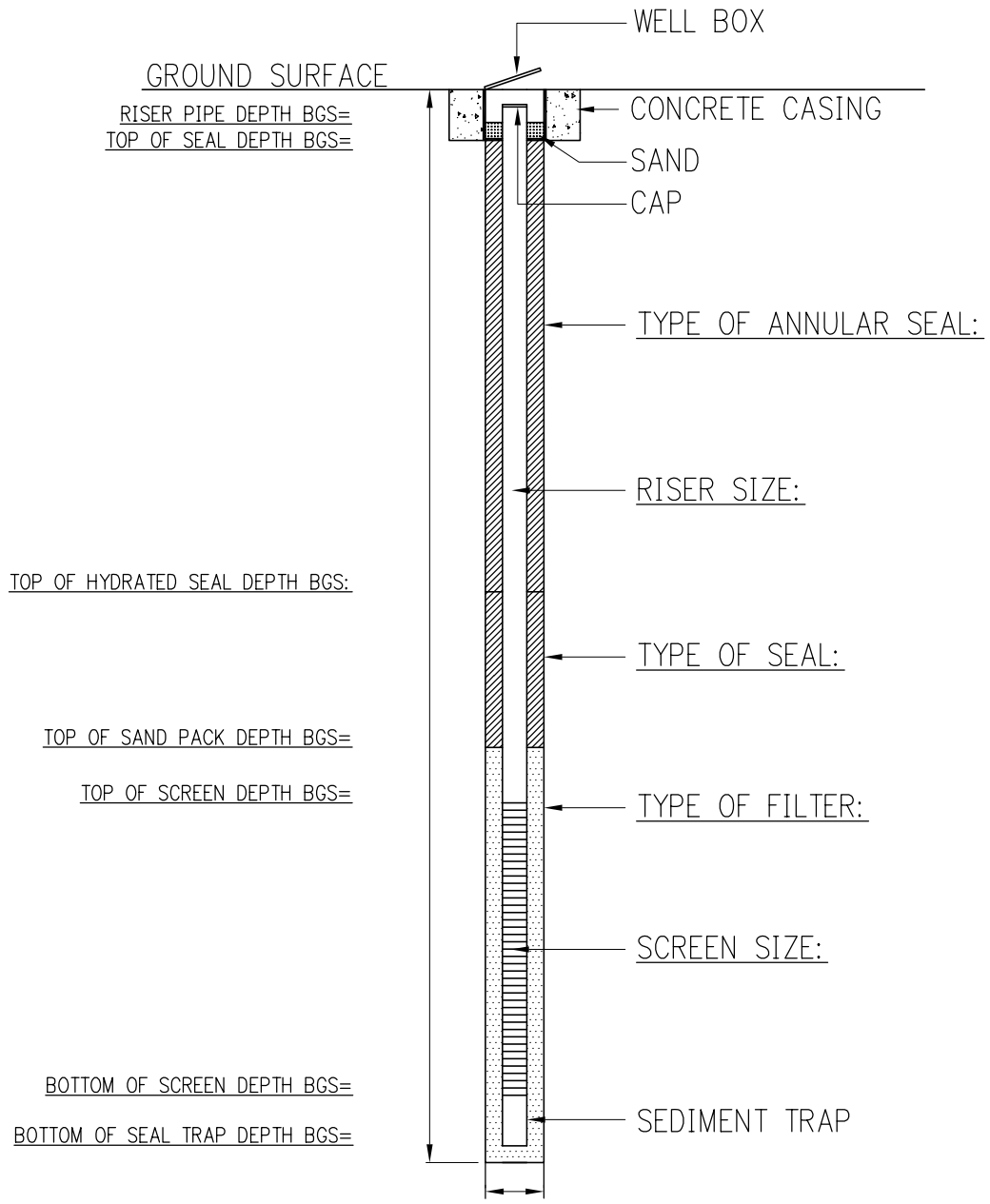
USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

ATTACHMENT A
WELL INSTALLATION LOGS

WELL INSTALLATION LOG

No. _____

CLIENT	COORDINATES N E	PROJECT	PROJECT NO.
PROJECT LOCATION		TOP OF RISER ELEVATION (DATUM)	DATE
STRATUM MONITORED		LOGGED BY	
DRILLING COMPANY		APPROVED BY	



NOT TO SCALE

METHOD OF INSTALLATION:

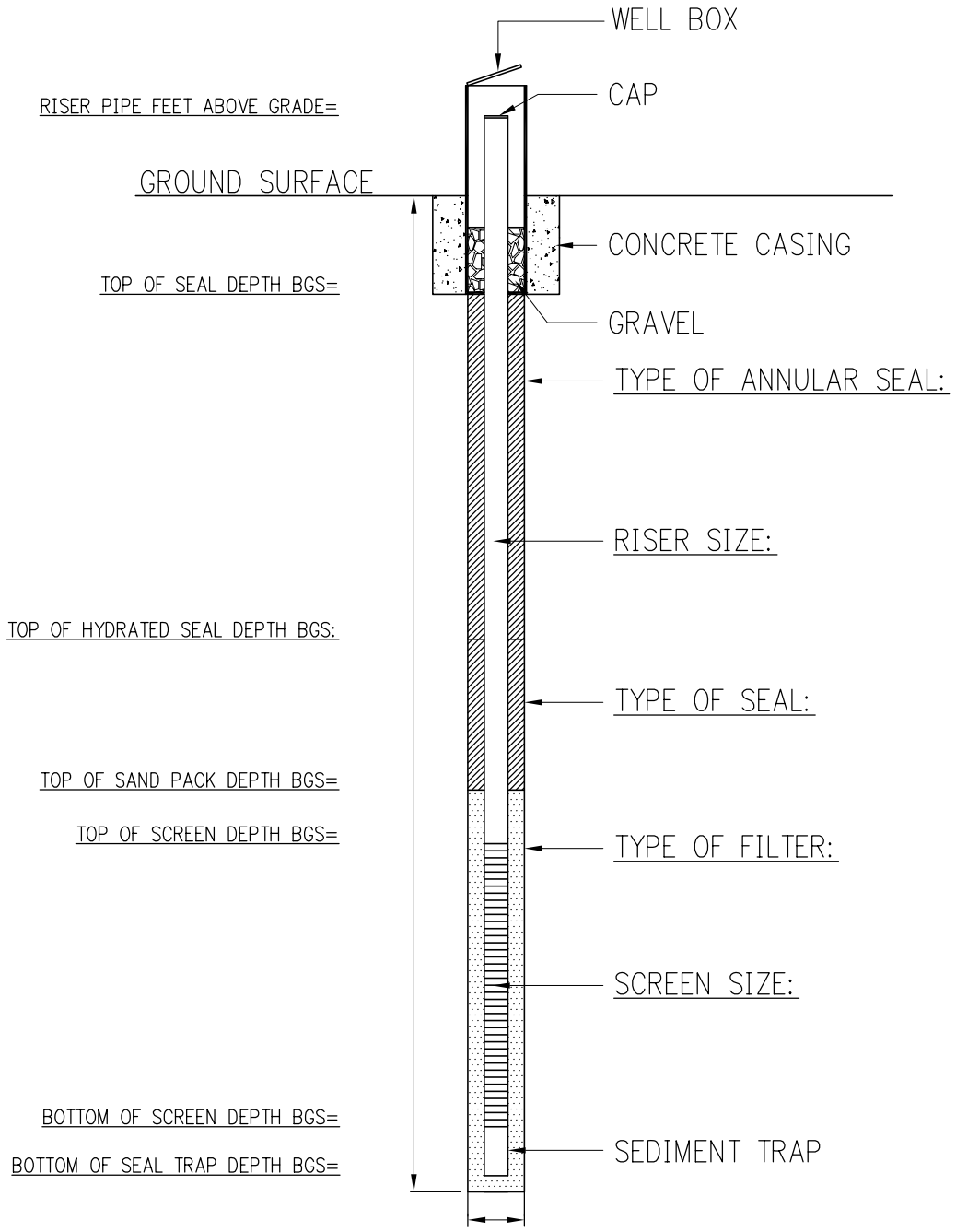
REMARKS:

I:\CAD\BMC\TEMPLATES\FLUSH MOUNT WELL LOG.NL

WELL INSTALLATION LOG

No. _____

CLIENT	COORDINATES N E	PROJECT	PROJECT NO.
PROJECT LOCATION		TOP OF RISER ELEVATION (DATUM)	DATE
STRATUM MONITORED		LOGGED BY	
DRILLING COMPANY		APPROVED BY	



NOT TO SCALE

METHOD OF INSTALLATION:

REMARKS:

I:\CAD\BMC\TEMPLATES\STICK UP WELL LOG NL

STANDARD OPERATING PROCEDURE NO. SAS-05-04

WELL DEVELOPMENT Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for developing wells. Well development is conducted to 1) remove drilling fluids or mudcake from the filter pack, borehole wall, and formation materials, 2) remove any loose, fine-grain, formation materials (e.g. fine sand, silt, and clay) from the filter pack and well screen to eliminate, to the extent possible, impact the integrity of groundwater and/or product samples and aquifer characterization test results, and 3) restore the natural permeability of the formation adjacent to the borehole.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials will vary by development method. Field personnel should use the equipment and materials required by the Work Plan or otherwise specified for the development method(s) selected for the project. All non-disposable equipment, including pumps, hoses, containers, and bailers, shall be decontaminated before and after introduction into wells. Equipment decontamination should be performed in accordance with SOP ENV-04-05 and/or requirements of the Site-Specific Work Plan.

3.0 HEALTH AND SAFETY WARNING

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 DEVELOPMENT METHODS

4.1 Air Lifting

The airlift method involves pumping compressed air down an eductor pipe placed inside the well casing. Due to its inert characteristic, nitrogen is the preferred gas for air lifting. Pressure is applied intermittently and for short periods causing the water to surge up and down inside the casing. Once the desired surging is accomplished, continuously applied air pressure should be used to blow water and suspended sediments upward and out of the well.

The use of standard air for well development may impact permeability of the formation surrounding the well screen and groundwater quality. Considerable care must be exercised to avoid injecting air directly through the well screen. Air can become trapped in the formation materials outside the well screen and affect subsequent chemical analyses of water samples and hydraulic conductivity measurements. The bottom of the air pipe should not be placed below the top of the screened section of casing.

Another restriction of the use of air is the submergence factor. The submergence factor is defined as the height of the water column above the bottom of the air pipe (in feet) divided by the total length of the air pipe. To result in efficient airlift operation, the submergence factor should be at least 20 percent. This may be difficult to achieve in shallow monitoring wells or wells that contain small volumes of water.

4.2 Surging or Plunging

A surge block is a round plunger with pliable edges (constructed of a material such as rubber belting) that will not catch on the well screen. Moving the surge block forcefully up and down inside the well screen causes the water to surge in and out through the screen accomplishing the desired cleaning action. The amount of pressure generated by the surging must be closely monitored to prevent cracking of the well casing or screen.

A well slug may also be used to create a surging effect through the filter pack and formation. A slug consists of a PVC rod or pipe (with capped ends) sufficiently weighted to rapidly sink in water. The slug is alternately lowered into and retrieved from the water in the casing to create a water level differential that induces flow

into or out of the well to accomplish the desired cleaning action. This method is less aggressive than using a surge block. For shallow wells or wells in which the water column in the casing is small, care must be exercised when lowering the slug so as not to drive the slug into the bottom of the casing or against the screens.

4.3 Bailing or Pumping

Bailers may be used for development of low-yielding wells or wells with a significant amount of sediment (approximately 10% in the well screen) to remove excess sediment. A bailer that is heavy enough to sink rapidly through the water can be raised and lowered through the water column to produce the surging action that is similar to that caused by a surge block or well slug. The bailer, however, has the added capability of removing turbid water and fines each time it is brought to the surface. Bailers are very useful for developing shallow and slow yielding wells. As with surge blocks, it is possible to produce pressure great enough to crack PVC casing. Bailers are the simplest and least costly method of developing a well, but are time-consuming.

Pumping can be used effectively in wells where recharge is rapid. The pump may be used to back flush and overpump (at rates that exceed purging and sampling rates) water in and out of the well screen. The type and size of the pump used is contingent upon the well design. Pumps also allow removal of turbid water and fines. However, pumps are more difficult to decontaminate than a bailer is.

5.0 EXECUTION

The following procedures shall be adhered to unless well development requirements are otherwise specified in the Site-Specific Work Plan:

1. Measure the depth to groundwater in accordance with the guidelines described in SOP ENV-08-02. The standing water volume (V) in the well to be developed shall be calculated using one of the following formula in accordance with the Site-Specific Work Plan:

   Borehole Volume Calculation

   $V = nA (B - C) + CD$

   Where, n = porosity of the filter pack;
   A = height (in feet) of the saturated filter pack;

B = volume (in gallons per foot) of water in the borehole (see Table below);
C = volume (in gallons per foot) of water in the well casing (see Table below); and
D = height of standing water column (in feet) in the well.

Well Volume Calculation

V = CD

Where, C = gallons per foot of water in the well casing (see Table below); and
D = height of standing water column (in feet) in the well.

Diameter-Specific Volume Per One Foot of Casing/Borehole

Diameter (Inches)	Volume Per Foot of Casing/Borehole (Gallons)		Diameter (Inches)	Volume Per Foot of Casing/Boring (Gallons)
0.25	0.0026		4.0	0.6528
0.50	0.0102		6.0	1.469
0.75	0.0230		8.0	2.611
1.0	0.0408		10.0	4.081
2.0	0.1632		12.0	5.876

2. Measure water quality parameters immediately prior to and during well development at a minimum frequency of once per well volume removed in accordance with SOP ENV-08-03. The water quality parameters should generally include pH, specific conductance and/or actual conductivity, temperature, dissolved oxygen, and turbidity, unless otherwise specified in the Work Plan. Record water quality parameters, as well as visual turbidity and evidence of impact (e.g. free phase product, sheen, odors, etc.) observations in the field logbook and/or on the appropriate field form.
3. Remove 10 standing water volumes or the volume required to achieve water quality parameter stabilize and visual clarity is achieved, whichever is less. A well that will not yield sufficient volume must be slowly bailed or pumped, allowed to recover to within 90% of the pre-development standing water volume, and then slowly bailed or pumped a second time, with a maximum of five purge periods. The criteria for parameter stability are summarized below.

4. Increase the minimum development water volume when drilling water and/or fluids are lost prior to well development. This additional purge volume shall be at least three times the volume of lost fluid.

Water Quality Parameter	Stability Criteria[1]
pH	+/- 0.1 Std. Units
Temperature	+/- 0.1°C
Specific Conductance or Actual Conductivity	+/- 3% microsiemens/cm
Dissolved Oxygen	+/- 0.3 milligrams/Liter
Turbidity	<10 NTUs or + 10% when turbidity is greater than 10 NTUs and/or visually clear water

5. Containerize development water in approved, labeled containers (e.g. 55-gallon drums, polyethylene storage tanks, baker tanks, etc.) as required by the Site-Specific Work Plan or otherwise specified.

6.0 DOCUMENTATION

Well development activities will be documented in the field logbook and/or appropriate field form included in Appendix B of the FSP, describing the procedures used and any significant occurrences that are observed during development such as apparent recharge rates in the well, condition of the groundwater, and organic vapor readings. Well development data including the depth to static water, standing water volume in the well, standing water volume calculations, total volume of water removed, number of well volumes removed, and water quality parameters will be recorded in the field logbook and/or on the field activity form (Appendix B of the FSP).

7.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 1992, Monitoring Well Development Guidelines for Superfund Project Managers, Office of Solid Waste and Emergency Response, http://www.epa.gov/tio/tsp/download/welldevelp.pdf.

USEPA, 2002, Ecological Assessment Standard Operating Procedures and Quality Assurance Manual, SESD, Region 4, Ecological Assessment Branch, Athens, Georgia.

[1] USEPA, May 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, Revision 2, EPA/542/S-02/001.

USEPA, May 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, Regions 5 and 10, EPA/542/S-02/001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-05-05

BOREHOLE AND WELL ABANDONMENT Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for borehole and well abandonment. When boreholes and wells are no longer needed to complete project goals and objectives, they must be properly abandoned to prevent them from acting as a conduit for migration of contaminants from the ground surface to the water table or between transmissive zones.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials may vary based on borehole and well accessibility and depth and well construction. Field personnel should use the equipment and materials required by the Site-Specific Work Plan or otherwise specified for the project. All non-disposable equipment shall be decontaminated before and after introduction into borehole or well. Equipment Decontamination should be performed in accordance with SOP SAS-04-05 and/or requirements of the Site-Specific Work Plan.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

Borehole and well abandonment procedures should meet applicable regulatory agency requirements. In addition, licensing and/or certification of the driller may be required. A trained supervising technician (e.g. geologist, hydrogeologist, engineer, or environmental scientist) should be present during well abandonment to document the activities. The supervising technician should complete and submit a well abandonment form, if required, to the appropriate regulatory agency. Attachment A contains the Illinois Department of Public Health Water Well Sealing Form as an example. If wells are abandoned in other states, the relevant forms and procedures shall be implemented.

5.0 EXECUTION

Unless otherwise specified in the Site-Specific Work Plan, the following guidelines shall be followed. The preferred well abandonment method is to completely remove the well casing and screen from the borehole. This may be accomplished by auguring with a hollow-stem auger over the well casing down to the bottom of the borehole, thereby removing the grout, bentonite seal, and filter pack from the hole. The well casing shall be then removed from the borehole with the drill rig. The remaining borehole and boreholes not utilized for the construction of a monitoring well, is subsequently backfilled with the appropriate backfill material. The backfill material (e.g. bentonite, Portland cement, etc) shall be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method) to within 30 inches of the ground surface. . The annular space shall be filled with bentonite chips, grout, or granules to at least 30 inches bgs unless land use requires a design modification to use native material (gravel, soil, etc.) or material in adjacent areas (asphalt, concrete, etc.) to bring the former well location to grade. If the area has heavy traffic and/or construction use, the location will be barricaded until the plug has cured or concrete plug recessed below ground surface will be used to maintain the surface seal. This abandonment method can typically be accomplished on small-diameter wells (4-inches or less in diameter) without much difficulty.

The use of hollow-stem augers for casing removal on large-diameter wells (diameter greater than 4-inches) typically ranges from very difficult to almost impossible. On large-diameter wells with little to no grout, a drill stem with a tapered wedge assembly or solid-stem auger should be used to ream out the borehole and extract the well materials. Wells that are badly corroded and/or have thickly grouted annular space have a tendency to twist and/or break off in the borehole. Should this occur, the well would be grouted with the

remaining casing left in the borehole. In this case, the well and borehole shall be pressure grouted by placing a tremie pipe in bottom of the well casing, which will be the well screen or bottom sump area below the well screen. The pressurized grout will be forced out through the well screen into the filter pack and up the inside of the well casing sealing holes and breaks that are present. The tremie pipe shall be retracted slowly as the grout fills the casing. The annular space shall be filled with bentonite chips, grout, or granules to at least 30 inches bgs. The well casing shall then be cut off at least 30 inches below. Native material (gravel, soil, etc.) or material in adjacent areas (asphalt, concrete, etc.) may be used to bring the former well location to grade. If the casing has been broken off below the surface, the grout shall be tremied to within 30 inches of the ground surface and then finished similar to the surrounding features.

Brittle polyvinyl chloride (PVC) well casings may be more difficult to remove from the borehole than stainless-steel casings. If the PVC well casing breaks during removal, the borehole shall be cleaned out by using a drag bit or roller cone bit with the wet rotary method to grind the casing into small cuttings that will be flushed out of the borehole by the drilling fluid. Another method is to use a solid-stem auger with a carbide auger head to grind the PVC casing into small cuttings that will be brought to the surface by the rotating flights. After the casing materials have been removed from the borehole, the borehole shall be cleaned out and pressure grouted with the approved grouting materials. As previously stated, the borehole shall be finished with a concrete surface plug or site-specific surface restoration material with adequate surface protection, unless otherwise directed or required by the Site-Specific Work Plan.

6.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2005, D5299-99 (2005) Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

Author:	T. Gilles	Q2R & Approval By:	C. Barry	Q3R & Approval By:	M. Kelley

ATTACHMENT A
BOREHOLE / WELL ABANDONMENT FORM

BOREHOLE / WELL ABANDONMENT FIELD FORM

PROJECT INFORMATION

Site: _____ Client: _____

Project Number: _____ Task #: _____ Start Date: _____ Time: _____

Field Personnel: _____ Finish Date: _____ Time: _____

GENERAL INFORMATION

Ownership (Controlling Party): _____

Street Address: _____

City: _____

County: _____

State: _____ Zip: _____

Township: _____ Range: _____ Section: _____

_____ 1/4 of the _____ 1/4 of the _____ 1/4

If Known, Latitude: _____ Longitude: _____

If Known*, Northing: _____ Easting: _____

*Coordinate System: _____

Reason for Abandonment:

Permit Number (If applicable): _____

BOREHOLE / WELL INFORMATION

Borehole / Well ID: _____ Unique Well ID:

Installation Date: _____

☐ Borehole
☐ Monitoring Well
☐ Water Well
☐ Other (specify): _____

Attach Well Completion Report, if available

Construction Type:

☐ Drilled ☐ Driven (Sandpoint)
☐ Other (specify): _____

Formation Type:

☐ Unconsolidated Materials ☐ Bedrock

Borehole/Well Details:

Borehole Diameter: _____ Inches

Total Borehole Depth: _____ FT BGS

Casing Diameter: _____ Inches ☐ Not Applicable

Total Casing Depth: _____ FT BGS ☐ Not Applicable

Depth to Water: FT BGS ☐ Not Encountered

SEALING INFORMATION

Pump & Piping Removed? ☐ Yes ☐ No ☐ Not Applicable

Liner(s) Removed? ☐ Yes ☐ No ☐ Not Applicable

Screen Removed? ☐ Yes ☐ No ☐ Not Applicable

Entire Casing Removed? ☐ Yes ☐ No* ☐ Not Applicable

If No, Upper 2 feet Removed? ☐ Yes ☐ No

Method of Sealing Material Placement:

☐ Conductor Pipe - Gravity ☐ Tremie Pipe - Pumped

☐ Screened & Poured ☐ Other (specify): _____

Sealing Material Rose to Surface? ☐ Yes ☐ No

Material Settled After 24 Hours? ☐ Yes* ☐ No

*If Yes, Was Hole Re-Topped? ☐ Yes ☐ No

Sealing Material Used	From	To	Volume/Quantity
	Surface		

SEALING WORK PERFORMED BY

Individual's Name: _____ License Number:

Company Name: _____

Street Address: _____

City: _____ State: _____ Zip: _____

STANDARD OPERATING PROCEDURE NO. SAS-05-06

TEST PIT EXCAVATION, LOGGING AND SAMPLE COLLECTION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for conducting test pit excavation, logging and sample collection as described in the Site-Specific Work Plan, or as otherwise specified, for the purposes of characterizing subsurface conditions at the site.

2.0 EQUIPMENT AND MATERIALS

- General:
  - Excavator or backhoe;
  - Metal shovel;
  - Spray paint or survey lathe and tape;
  - Visquene sheeting;
  - Tape measure in 0.01-foot increments;
  - Field logbook and field boring log forms;
  - Pen(s) with waterproof, non-erasable ink;
  - 5-gallon bucket and wire or nylon brushes, decontamination water, laboratory grade detergent (Alconox or similar), and paper towels;
  - Aluminum foil or roll-plastic wrap;
  - Stakes and fluorescent flagging tape;
  - Camera; and
  - Personnel protective equipment, as appropriate.
- Soil Logging:
  - Knife, spatula, carpenter's 5-in-1 tool or similar cutting tool;
  - Soil color chart;
  - Comparative charts; and

- Pocket penetrometer.

- Soil Sampling:
  - Sample containers and labels;
  - Sample cutting/extracting equipment (scoops, trowels, shovels, hand augers);
  - Metal mixing bowls;
  - Coolers and ice;
  - Chain of custody forms;
  - Custody seals;
  - Gallon size sealable plastic bags; and
  - Clear plastic packaging tape.

3.0 HEALTH AND SAFETY WARNING

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 GENERAL PROCEDURES

Test pit procedures shall be conducted only by a trained logging technician. Subsurface utilities shall be cleared prior to mobilization to the site in accordance with SOP ENV-05-01. Field data and observations associated with test pit activities shall be documented in accordance with SOP ENV-01-01, if not otherwise specified in this SOP. All test pit excavation activities should be recorded in a field logbook and/or on a test pit excavation field form. In addition, equipment used while logging shall be decontaminated between test pit locations in accordance with the SOP ENV-04-05 or as otherwise specified in the Quality Assurance Project Plan (QAPP) and/or Site-Specific Work Plan.

5.0 DOCUMENTATION PROCEDURES

The field technician shall record all pertinent excavation information in the field logbook and/or on the appropriate field form. At a minimum, the following technical information with respect to excavation operations and observations shall be recorded, if applicable:

- Project name and number;
- Location (e.g. test pit number) or other sample station identification, including a rough sketch;
- Name of the logging technician overseeing the excavation operations;
- Excavating equipment manufacturer and model;
- Excavating company name and city and state of origin;
- Equipment operator and assistant(s) names;
- Excavation start time and date;
- Excavation completion time and date;
- Excavation dimensions (length and width, and depth)
- Description of soil and/or rock classification and lithology;
- Lithologic changes and boundaries;
- Depth to water first encountered during excavation
- Depth to stabilized water level following excavation
- Sample identifications; depths and time collected for chemical and geotechnical samples;
- Evidence of impact (e.g. staining, odors, free-phase product, etc.); and
- Problems with the excavating equipment or process.

6.0 TEST PIT EXCAVATION PROCEDURES

- Identify the test pit locations and mark limits of excavation using spray paint or survey lathe and tape.
- Confirm absence of subsurface utilities in the test pit excavation areas. If subsurface utilities are present in test pit location, contact the project manager to discuss alternative locations for test pit.

- Lay visquene sheeting to be used for soil stockpiling on ground next to test pit location and secure in place. If topsoil is present, it may be stockpiled separately for restoration of ground surface when test pit is completed.
- Begin excavation making shallow cuts of 6 inches to 1 foot to allow descriptive logging of soil and soil transitions. Stockpile soil on visquene sheeting.
- Sketch the development of the test pit in the field notebook. Complete vertical profiles at multiple locations along the length of the test pit if variation of subsurface materials occurs along the length. Sketch a cross section of the longitudinal length of the test pit.
- Record physical characteristics of the material excavated including Unified Soil Classification System (USCS) soil type, litho logy, color, odor, moisture, structures, foreign objects and observations of environmental impacts in the field logbook or field form. Follow soil description, classification, and visual observations of affected soil procedures provided in SOP ENV-05-02.
- Take photographs to document excavation and log photographs in the field logbook or on the field form.
- If soil samples are required for chemical or geotechnical analysis, collect samples from the base or side walls. If the test pit depth has unsafe conditions (deeper than can be safely accessed, unstable walls, or other safety concerns), collect samples directly from the excavation bucket or soil stockpile. Samples will be collected as soon as possible to minimize potential volatilization from soil in the bucket of the excavator or soil stockpile. Have communication signals set up with excavator operator and/or other subcontractor personnel to indicate that a soil sample will be taken so that the equipment can be stopped for safe sample retrieval. Do not at any time go into the test pit.
- Soil samples shall be collected in accordance with SOP ENV-06-01. Decontaminate sampling equipment between each sample collected in accordance with SOP ENV-04-04. Samples shall be prepared for analysis in accordance with SOP ENV-03-01.
- Once the excavation is complete, record the depth, length and width of the excavation in the field logbook or on the field form.
- Backfill the test pit with the material excavated from the test pit unless other backfilling instructions are specified in the Site-Specific Work Plan. If topsoil was set aside for ground surface restoration, place it on top of the excavation area.
- Decontaminate excavator or backhoe bucket between each test pit in accordance with SOP ENV-04-04.

- Test pits must be backfilled before the end of the work day; no test pits shall be left open overnight.
- Replace markings for limits of test pit excavations if they are to be located by survey at a later date.

7.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-05-07

TEST PIT BACKFILLING AND COMPACTION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for backfilling and compacting test pits. When test pits are no longer need to complete project goals and objectives, they must be properly backfilled and compacted to minimize health and safety liabilities, prevent them from acting as a conduit for migration of contaminants, and return the location to pre-excavation conditions.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials may vary based on test pit accessibility and depth. Field personnel should use the equipment and materials required by the Site-Specific Work Plan or otherwise specified for the project. All non-disposable equipment shall be decontaminated after introduction into the test pit. Equipment decontamination should be performed in accordance with SOP ENV-04-04 and/or requirements of the Site-Specific Work Plan.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

The preference for test pit backfilling is generally to return excavated materials to the test pit in the order in which they were excavated. However, the presence of suspected contaminants may require another source of backfill material. The selection of backfill material will be based on several factors, including but not limited to, concentrations of contaminants in excavated materials, test pit location (e.g. street, landscaped area, etc.), subsurface site features, ability to mechanically compact backfill materials, engineering evaluations, health and safety concerns, and access agreements. If the test pit extends below the water table, 3-inch stone shall be used to backfill the excavation to the top of the water table. Backfill material(s) will be specified in the Site-Specific Work Plan. The excavation area shall be returned to pre-excavation conditions or as otherwise specified in the Site-Specific Work Plan, applicable permit(s), and/or access agreement(s). As necessary, a qualified engineer will be consulted prior to selection of backfill and compaction material(s), equipment and method(s).

5.0 BACKFILLING AND COMPACTION

5.1 Trench Box Methods

The test pit excavated using a trench box will be backfilled, as the trench box is systematically raised, to ground surface. Care will be taken to minimize bridging as the backfill is placed. When test pit excavations exceed 4 feet in depth and self-compacting backfill material is not used, the backfill material will be placed in lifts and compacted using the excavator bucket, excavator track/wheel, or vibratory plate compactor or as specified in the Site-Specific Work Plan, applicable permit(s), and/or access agreement(s).

5.2 End Dump Methods

Test pits excavated without a trench box could be backfilled using end dump methods. When test pit excavations exceed 4 feet in depth and self-compacting backfill material is not used, the backfill material will be placed in lifts and compacted using the excavator bucket, excavator track/wheel, or vibratory plate compactor or as specified in the Site-Specific Work Plan, applicable permit(s) and/or access agreement(s).

6.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

AIR KNIFE AND/OR VACUUM EXCAVATION

1 PURPOSE

This standard operating procedure (SOP) describes the guidelines for conducting Air Knife and/or Vacuum Excavations. Air knife excavation is generally performed to field-verify the location of subsurface utilities and may be used to install wells or probes in areas where conventional drilling methods have the potential to damage subsurface utilities. Air knife excavation works by disturbing the soil with a high-pressure stream of air. The loose soil is then extracted with an attached high-suction vacuum hose that transports the cuttings to an aboveground storage container. This excavation method is designed to efficiently remove soil in a manner that will not damage subsurface utilities and is not meant for subsurface soil sampling. Any air knife excavation will be performed by a qualified contractor. This method may be useful for evaluating utility corridors as a preferential pathway for contaminant migration. The air knife excavation method may be used to locate a subsurface utility, evaluate the condition of the fill material around the utility, and determine if soil sampling and/or placement of monitoring equipment (e.g., soil vapor probe) can be done safely within the fill material.

2 EQUIPMENT AND MATERIALS

- Field logbook;
- Pens with waterproof and non-erasable ink;
- Tape Measure;
- Camera; and
- Personal protective equipment, as appropriate.

3 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in the investigation area, or certain work activities may exist on the site. Protocols are established in the Multi-Site Health and Safety Plan (HASP) and presented in each site-specific HASP based on corporate health and safety policies and manuals, past field experience, specific-site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees and subcontractor personnel will have read and understood the HASP and all

revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP, their individual responsibilities, and agree to abide by the provisions of the HASP.

4 GENERAL PROCEDURES

Air knife excavation oversight shall be conducted only by a trained field technician. Subsurface utilities shall be cleared prior to mobilization to the site in accordance with SOP SAS-05-01. Field data and observations associated with air knife excavation shall be documented in accordance with SOP SAS-01-01, if not otherwise specified in this SOP. All air knife excavation activities shall be recorded in a field logbook and/or on an appropriate field form.

5 DOCUMENTATION PROCEDURES

The field technician shall record all pertinent excavation information in the field logbook and/or on the appropriate field form. At a minimum, the following technical information with respect to excavation operations and observations shall be recorded, if applicable:

- Project name and number;
- Location (e.g., monitoring well number) or other identification, including a rough sketch showing nearby utilities, if any;
- Name of the field technician overseeing the excavation operations;
- Excavation equipment manufacturer and model;
- Excavation company name and city and state of origin;
- Equipment operator and assistant(s) names;
- Excavation start time and date;
- Excavation dimensions (i.e., diameter and depth);
- Notable descriptions of material removed from the borehole (see SAS-05-02 for soil sample classification and description);
- Approximate depth to water encountered;
- Evidence of impact (e.g., odors or non-aqueous phase liquid [NAPL]) associated with extracted or sidewall materials); and
- Problems encountered during excavation.

6 EQUIPMENT DECONTAMINATION PROCEDURES

All decontamination will be performed, as needed, according to SOP SAS-04-04.

7 SOIL SAMPLING

Air knife excavation is a "blind" process where soil horizons are not preserved for sampling during excavation. If soil samples are desired, conventional methods (e.g., hand auger, direct push, or hollow stem auger with split spoon) can be used at a nearby location that will not damage subsurface utilities. Air knife excavations can be a useful tool for safely locating soil samples and/or monitoring equipment in close proximity to subsurface utilities. See SOP SAS-06-01 for soil sampling for chemical analyses and geotechnical testing.

8 INVESTIGATION-DERIVED WASTE (IDW)

Excavation cuttings will be containerized and disposed of per the specifications in the Site-Specific Work Plan. No liquid IDW will be generated. Further discussion of IDW can be found in Section 9 of the "Multi-Site Field Sampling Plan, Former Manufactured Gas Plant Sites, Revision 4," September 8, 2008.

9 REFERENCES

Integrys, 2008. *Multi-Site Field Sampling Plan*, Revision 4, September 2008.
Integrys, 2007. *Multi-Site Health and Safety Plan Former Manufactured Gas Plant Sites*, August 2007.

SOP SERIES SAS-06

SOIL SAMPLING AND MEASUREMENT PROCEDURES

STANDARD OPERATING PROCEDURE NO. SAS-06-01

SOIL SAMPLING FOR CHEMICAL ANALYSES AND GEOTECHNICAL TESTING Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for obtaining surface and subsurface soil samples as stated in the Site-Specific Work Plan or as otherwise specified. Soil sampling is conducted for the purpose of chemical analyses and geotechnical testing to evaluate surface and subsurface conditions.

2.0 EQUIPMENT AND MATERIALS

In addition to materials provided by a subcontractor, the field personnel should have the following:

- Sample bottles/containers and labels;
- Sample cutting/extracting equipment (scoops, trowels, shovels, hand augers);
- Field logbook and/or the appropriate field form(s);
- Depth and length measurement devices with 0.01-foot measurement units;
- Camera;
- Stakes and fluorescent flagging tape;
- Decontamination materials;
- Coolers and ice;
- Chain of custody forms;
- Custody seals;
- Gallon size sealable plastic bags;
- Clear plastic packaging tape; and
- Personal protective equipment.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 SAMPLE TYPE, METHOD, AND EQUIPMENT SELECTION

4.1 Preparation

Site-Specific Work and/or Field Sampling Plans (FSP) which involve soil sampling shall be carefully conceived with respect to data quality objectives (DQOs) and cost effectiveness. Soil samples shall be strategically located to collect a representative fraction of soils with the minimum number of samples. To facilitate complete and successful sampling efforts by minimizing uncertainties with respect to site characterization the following factors shall, at a minimum, by considered during preparation activities:

- Project goals and DQOs;
- Location and duration of historical property uses (if available);
- Location and duration of current property uses;
- Chemical properties of contaminants of potential concern (COPCs);
- Anticipated location(s) of COPCs (e.g. surface, subsurface, etc.);
- Anticipated geologic conditions including presence and elevation of groundwater;
- Site accessibility; and
- Results of previous site reconnaissance and investigations (if available).

4.2 Field Considerations

Field personnel shall review and be familiar with Site-Specific Work and/or FSPs prior to commencement of sampling activities. Field personnel will also facilitate complete and successful sampling efforts by calibrating and operating field instruments/meters used for sample media screening in accordance with SOP ENV-02-01. In addition, field personnel shall be cognizant of the following during investigative activities:

- Indications of COPCs not previously anticipated;
- Evidence (e.g. visual, olfactory, etc.) of COPCs in locations not previously anticipated;
- Geologic conditions not anticipated;
- Changes in site accessibility; and
- Meteorological conditions (e.g. high humidity, rain, etc.) that have the potential to negatively impact operation and performance of field screening instruments, and sample quality.

Field personnel shall notify the Project Manager when field conditions and observations deviate from those anticipated during sampling event preparations. The Project Manager shall approve any deviation from the Work and/or Sampling Plans prior its occurrence. Deviations and approval to deviate from Site-Specific Work and/or FSPs shall be documented in the field logbook and/or on the appropriate field form by the field personnel.

5.0 SAMPLE TYPES

5.1 Grab Samples

Grab samples are collected to identify and quantify compounds at a specific location or interval. Grab samples are limited in areal and vertical extent. A grab sample shall be comprised of no more than the minimum amount of soil necessary to obtain the volume of sample dictated by the required sample container.

5.2 Composite Samples

Composite samples are a mixture of a given number of sub-samples/aliquots and are collected to characterize the average composition of a given surface area, vertical interval, etc. The number of sub-samples/aliquots forming a composite sample shall remain consistent with the context of the investigation. The number and pattern for collection of sub-samples/aliquots within a grid, interval, etc. shall be selected based on project goals and DQOs and shall not change. Composite sampling is associated with two potential interferences:

1. Low concentrations, if present in individual sub-samples/aliquots, may be diluted to the extent that the total composite concentration is below the analytical reporting limits.
2. Sub-samples/aliquots that are predominantly moist clay can be difficult to composite to produce a homogenous mixture. The resulting sample, as represented by the portion selected by the analytical chemist, may not be representative of an average of all the sub-samples/aliquots.

6.0 SAMPLING METHOD

6.1 Random

Random sampling removes the subjective collection of samples based on personal judgment. Soil samples are typically selected from all investigation area(s) when a suspected area of contamination is unknown. Generally, this method is utilized with site screening investigations when there is no strong indication of contamination or distinct depositional areas are present that provide excellent screening samples.

6.2 Biased

Biased sampling involves the collection of samples based on evidence of contamination (e.g. staining, stressed vegetation, elevated field screening results, etc.). Background and control samples are also considered biased, since they are collected from locations anticipated to be impacted or expected to be clean.

6.3 Grid-Based

Grid-based sampling involves the systematic collection of samples based on the size and configuration of an area. This approach is used to characterize the presence and distribution of contaminants and is commonly utilized for large areas. Grid size will be selected during the preparation phase and shall be specified in the Work or Sampling Plan. Common grid sizes shall be developed based on the size and configuration of the area, project goals, and DQOs. It may be appropriate and acceptable to integrate several different grid sizes in a single investigation.

When a Site is extremely large (typically over several acres), it may not be practical and cost-effective to consider sampling every grid. In this case, it will be necessary to statistically select a sub-set of the total number of grids in order to reduce the number of samples collected. On the other hand, it may be more appropriate to use relatively inexpensive screening level analytical techniques to define the areas that will

need to be sampled and analyzed for a higher level of data quality. In all cases, grid points shall be located using a site survey and shall be semi-permanently marked to facilitate relocating the sample locations for subsequent sampling.

7.0 SAMPLING EQUIPMENT AND PROCEDURES

7.1 Manual Sampling

In general, hand sampling using manually operated equipment is a quick and inexpensive sampling technique for shallow depths when precise data or high quality control is generally not required. The most common hand-operated samplers are hand augers, plugs, tubes, split-barrel or fixed piston samplers that are pushed or driven by hand.

Hand augers are easily used at depths less than 10 feet. The most commonly used, manually-operated hand augers include the ship, closed-spiral, and open-spiral augers. In operation, a hand auger shall be attached to the bottom of a length of pipe that has a cross-arm at the top. The hole shall be drilled by turning this cross-arm at the same time the operator presses the auger into the ground. As the auger is advanced and becomes filled with soil, it shall be taken from the hole, and the soil shall be removed. Additional lengths of pipe will be added as required to reach the sampling depth as required by the Site-Specific Work Plan or otherwise specified. Care shall be taken to prevent (to the extent possible) mixing of the soil from upper portions of the hole with lower samples. This is most likely to be a problem when augers are used to advance a hole and obtain samples from soil cuttings.

Pushed samplers can be used to obtain samples within about 3 feet of the surface or, with appropriate extensions, ahead of an augured hole. The sampler will be pushed to the desire depth by the operator. The pusher sampler shall be used with extension(s) and/or in combination with a hand auger to reach sample depths greater than 3 feet below ground surface. When the sampler becomes filled with soil, it shall be taken from the hole and the soil removed. Care shall be taken to prevent mixing of soil from upper portions of the hole with lower samples.

Because of the unpredictable operations that may have been used at many uncontrolled waste sites, sampling devices will never be forced into an abruptly hard material. The stiffness may be a natural lithology change, a rock ledge or cobble, or a buried drum. If resistance is encountered while auguring or pushing a sampler, the procedure will be stopped. The depth at which resistance was met should be recorded into the field logbook and/or on the appropriate field form.

7.2 Split-Spoon Sampler

The split-spoon sampler is a thick-walled steel tube that is split lengthwise. A cutting shoe is attached to the lower end of the barrel; the upper end contains a check valve and is connected to the drilling rods. When a boring is advanced to the point that a sample is to be taken, drill tools are removed, and the sampler is lowered into the hole attached to the bottom of the drill rods.

The split-spoon sampler is driven by a 140-lb hammer falling 30 inches. The split-spoon sampler shall be driven 18 inches into the ground or until 50 blows have been applied in a 6-inch increment, a total of 100 blows have been applied, or there is no observable advance of the sampler after 10 successive blows. The effort taken to drive the sampler shall be recorded at 6-inch intervals and the sampler shall be removed from the boring. The density of the sampled material shall be determined by summing the blow counts for the second and third 6 inches of penetration ("standard penetration resistance" or "N-value") per ASTM D 1586-99. Only disturbed samples are obtained using this procedure.

The standard size split-spoon sampler is 2-inch outside diameter (OD), $1^3/8$-inch inside diameter (ID), and 24 inches long. When soil samples are taken for chemical analysis, a 2- or 2½-inch ID sampler shall be used to provide a larger volume of material, but cannot be used to calculate strength or density properties as stated in the ASTM D 1586-99 test method.

Upon retrieval, excess soil or drilling fluid shall be rinsed or wiped from the sampler's exterior, the cutting shoe removed, and sampler broke open into the two halves. The sample shall be logged and classified in accordance with SOP ENV-05-03. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-approved and analytical-method required sample containers. The sampler tube

shall then be decontaminated. The split-spoon sampler shall be decontaminated between sample intervals in accordance with SOP ENV-04-05.

Liner tubes or sleeves may be incorporated in certain samplers to contain samples temporarily. The liner tubes may be constructed from brass, plastic, or other inert materials used to store and transport the samples. If a sample is to be stored in the liner tube, the tube ends shall first be covered with Teflon film, followed by a plastic slip cap. On each sample end, the Teflon film shall be trimmed, and the cap sealed with vinyl tape to the liner tube. If the sampler is not to be stored in the liner, it will be transferred from the sampler to the appropriate sample container using either the liner tube or a stainless steel or plastic spoon or spatula.

When taking samples for geotechnical testing, the disturbed soil samples shall be removed from the sampler are placed in a sealable glass jar or other containers approved by the geotechnical laboratory and labeled to indicate the project name and number, boring number, sample number, and depths at top and bottom of the sample interval. This information shall be marked on the jar lid using a permanent marker. Other information required by the Site-Specific Work and/or FSP shall be recorded in the field logbook and/or on the appropriate field form.

7.3 Continuous Core Barrel Sampler (CME-Type)

A continuous core barrel sampler (CME-Type) is 5 feet long and fits inside the lead auger of the hollow-stem auger column. The sampler retrieves a 5-foot section of partially disturbed soil samples. The sampler assembly consists of either a split barrel or solid barrel that can be used with or without liners. The split-barrel sampler is most commonly used because it is easier to access and remove the core samples. The core barrel sampler takes the place of the pilot bit, thereby reducing sampling time. The sampler is most efficient in clays, silts, and fine sand.

The sampler shall be attached to the drill rod and locked in-place inside the auger column. The open end of the sampler shall extend a short distance ahead of the cutting head of the lead auger. The hollow-stem auger column shall be advanced 5 feet while the soil enters the non-rotating core sampling barrel. The barrel shall then be retrieved with the drill rod, and the core extruded from the sampler. The sample shall be logged and

classified in accordance with SOP ENV-05-03. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-approved and analytical-method required sample containers. The sampler tube shall then be decontaminated in accordance with SOP ENV-04-05.

7.4 Thin-Walled (Shelby) Tube Samplers

Thin-walled samplers, such as a Shelby tube, should be used to collect relatively undisturbed samples of soil from borings. The samplers are constructed of steel tubing about 1 to 3 mm thick, depending upon its diameter. The lower end has a tapered cutting edge. The upper end is fastened to a sample head adapter with a check valve to help hold the sample in the tube when the tube is being withdrawn from the ground. Thin-walled tube samples are obtained by any one of several methods including pushed-tube, Pitcher sampler, Denison sampler, and piston sampler methods.

In obtaining pushed-tube samples, the tube shall be advanced by hydraulically pushing it in one continuous movement with the drill rig. At the end of the designated push interval and before lifting the sample, the tube shall be twisted to break the bottom of the sample. The tube shall be retrieved from the boring using the drill rig. One of two methods shall be employed for handling the sample once it is retrieved from the boring:

1. Extruding the sample from the sample tube in the field using an extruding device on the drilling rig, and subsequently handling and containerizing the specimen at the drilling site.
2. Leaving the sample in the sampling tube, preparing it for transportation, with subsequent extrusion and handling elsewhere.

A hydraulic extruder shall be used in all cases to minimize disturbance. To extrude the sample from the tube, the tube shall be connected to the extruding device in the appropriate fashion for that type extruder. Some extruding devices push the sample in the same direction that the sample entered the tube, pushing out the top, while others push it out the bottom. It does not matter for environmental sampling, but the orientation of the sample shall be known and kept clear by the sampling personnel. The sample shall be caught on a split section of PVC pipe lined with polyethylene sheeting or aluminum foil. Waxed paper will not be used. Drilling fluids shall be carefully poured off and cuttings or slough material at the top end of the sample raked away, leaving only the true sample interval. The sample shall be transferred to a cutting board by lifting with

the poly/sheeting or aluminum foil and length of the sample shall be measured. The sample shall be logged and classified in accordance with SOP ENV-05-02. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-approved and analytical-method required sample containers. The sampler tube shall then be decontaminated in accordance with SOP ENV-04-04.

Shelby tubes will not be reused for subsequent sampling intervals. A sufficient number of decontaminated sampling tubes shall be brought to the sampling location to complete the required scope of work and protected from being contaminated before use.

7.5 Cuttings or Wash Samples

Drill cuttings or wash samples may be taken as the boring is advanced. A stainless steel or plastic scoop shall be used to obtain a sample from the cuttings pile. The shovel used by drilling personnel to move cuttings shall be stainless steel. The sample shall be logged and classified in accordance with SOP ENV-05-02. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-approved and analytical-method required sample containers. The sampling equipment shall then be decontaminated in accordance with SOP ENV-04-04.

7.6 Test Pit Excavation and Sampling

Test pits, including trenches, consist of open shallow excavations used to determine the subsurface conditions for engineering and geological purposes. Test pits are typically conducted for subsurface characterization and to investigate underground structures that may contain impacts. Test pits shall be excavated manually or by machine (e.g. backhoe, bulldozer, or trackhoe), as required by the Site-Specific Work Plan or otherwise specified, and will be in accordance with OSHA regulations, 29 CFR 1926, 29 CFR 1910.120, and 29 CFR 1910.134. Test pit shall be logged and classified in accordance with SOP ENV-05-06.

Soil samples shall be collected from the backhoe/trackhoe bucket or directly from the wall or base of the test pit, depending on the depth of the pit. Disturbed samples shall be collected using a stainless steel scoop, shovel, or trowel. Undisturbed samples shall typically be collected using a hand auger and/or other coring tool. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-

approved and analytical-method required sample containers. The sampling equipment shall then be decontaminated in accordance with SOP ENV-04-04.

7.7 Surface Soil Sampling

Surface soil samples are collected to determine the surface soil conditions. Surface soil samples are generally collected at depths of less than 1 to 3 feet below the ground surface or as defined in SSWPs, considering DQOs. The use of discrete or composite samples will be determined in the SSWPs.

Before sample collection, all surface materials (i.e., excess gravel, vegetation, etc.) shall be removed from the sample location. Soil samples shall be collected using a stainless steel scoop, trowel, hand auger, or other equipment as required by the Site-Specific Work Plan or otherwise specified. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-approved and analytical-method required sample containers. The sampling equipment shall then be decontaminated in accordance with SOP ENV-04-04. The sample appearance, depth, and location should be recorded in the field logbook and/or on appropriate field form using the standardized descriptions in SOP ENV-05-03, Attachment E.

8.0 ANALYTICAL SAMPLE PREPARATION

Sections of the sample representative of the entire sampling interval shall be selected for chemical analyses and/or geotechnical testing. Based on analytical requirement and contracted laboratory specifications, chemical analysis samples shall be placed in appropriate sample containers. Specific analytical sample preparation procedures are as follows.

- Using a decontaminated sampling instrument, remove the desired thickness and volume of from the sample retrieval device.
- Conduct a direct screening of the sample with a photoionization detector (PID).
- Visual observations of affected soil will use the descriptors from SOP ENV-05-02 Attachment E.
- Describe and classify the sample in accordance with SOP ENV-05-02, Field Logging of Soil and Rocks.
- **Volatile Organic Compounds (VOCs) –** Discrete soil samples for VOC analyses will be collected as soon after sample retrieval as possible. Unless otherwise specified, soil samples for VOC analyses shall be collected by either Powerstop Handle™ or EnCore™ sampler methods in conformance to USEPA

Method 5035 requirements. Attachment A presents procedures for Powerstop Handle™ and EnCore™ sample collection. Secure container lid, apply label containing sample identification information and place in cooler with ice.

- **Semivolatile Organic Compounds (SVOCs), Metals, Cyanide, PCBs, Pesticides, Herbicides, and Organic Carbon –** Soil samples for these analytes will be collected after collecting VOCs. Place soil in a container for homogenization. Samples will be homogenized using clean stainless steel mixing bowls, spoons, knifes, etc. Sample aliquots will be placed directly from the sample retrieval device into the stainless steel bowl. The soil will be thoroughly mixed in the bowl to homogenize the sample and then placed directly into appropriate sample containers. Secure container lid, apply label containing sample identification information and place in cooler with ice.
- **Physical Characteristics –** For geotechnical testing of cohesive samples, cut minimally disturbed sections of the specimen and place it in the appropriate sample container. Samples for geotechnical testing, including Shelby tubes shall be handled and packaged in accordance with standard practices for geotechnical investigations or as required by the Site-Specific Work Plan or otherwise specified. If contamination potentially exists, samples shall be identified as potentially containing hazardous or toxic chemicals.
- Samples shall be identified, labeled, documented and prepared for transport in accordance with SOP ENV-03-01, Sample Identification, Labeling, Documentation and Packaging for Transport.
- SOP ENV-03-2 Chain-of-Custody procedures shall be followed in preparing the samples for transport to the analytical laboratory.
- Sampling equipment and tools shall be decontaminated between each sample in accordance with SOP ENV-04-05.

Containerize any investigation-derived solid and liquid waste, including decontamination water, label and store for disposal at an appropriate disposal facility. Consult with Project Manager regarding disposal of waste.

Samples should be preserved and holding times should be observed according to analytical requirements and laboratory specifications, as required by the Site-Specific Work and/or FSPs, or as otherwise specified. If

replicate or split samples are required, adjust the sections so that the additional samples are essentially identical.

9.0 DOCUMENTATION

Sample identification, labeling, and custody control shall be performed in accordance with requirements specified in SOP ENV-03-01 and ENV-03-02. Specific procedures for describing the samples and logging subsurface soil samples are presented in SOP ENV-05-03. Soil sampling activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP ENV-01-01 or as required by the Site-Specific Work Plan.

10.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 1999, D1586-99 Standard Method for Penetration Test and Split-Barrel Sampling of Soils.

ASTM International, 2000, D4220-95 (2000) Practices for Preserving and Transporting Soil Samples.

ASTM International, 2004, D5730-04 Guide for Site Characterization for Environmental Purposes with Emphasis on Soil, Rock, the Vadose Zone, and Ground Water.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

ATTACHMENT A
ENCORE™ AND POWERSTOP HANDLE™ SAMPLING PROCEDURES

ENCORE™ SOIL SAMPLING PROCEDURE

- Remove EnCore™ sampler and cap from its re-sealable pouch and attach T-handle to sampler body. (**Note**: when dealing with soft or sandy solid, it may be necessary to retract the plunger in the sampler before sample collection.)
- Using the T-handle for leverage, push the sampler into a freshly exposed surface of soil until the sampler is full.
- Brush any soil off the sampler head and securely attach the sampler cap by pushing with a twisting motion.
- Complete the sample label and attach to the sampler body; place labeled sampler in its re-sealable pouch and seal the pouch.
- Repeat the procedure for two additional samples collected from the same soil stratum or the same area. (**Note:** this step may be eliminated or the number of samples reduced if the suspected level of VOCs is known [i.e., low or high concentration sample]. Consult method 5035 or discuss procedure with an analytical laboratory for further details.)
- Use a stainless steel spoon or similar tool to collect an additional sample from the same soil stratum or the same area. Place collected material in a 2-ounce, wide-mouth jar with no preservatives. (**Note:** this additional soil volume is for dry weight and percent moisture determination. This step is not necessary if additional soil from the sample location is collected for other parameter analyses upon which dry weight and percent moisture will be determined.)
- Immediately place samples in a cooler with ice.

Ship EnCore™ samples (next day priority delivery) to the contract laboratory the day they are collected. Alternatively, arrange to have samples picked-up by the laboratory or delivered to the laboratory by field personnel within 24 hours of collection. These sample shipment or pickup timelines must be achieved to ensure the laboratory performs sample preservation or analysis within 48 hours of sample collection.

POWERSTOP HANDLE™ SAMPLING PROCEDURES

1. Load Sampling Device

Insert EasyDraw Syringe™ into the appropriate slot (5 or 10-gram heavy, 5 or 10-gram medium, 5 or 10-gram light or 13 gram position) on the Powerstop Handle™ device and remove end cap from syringe.

EPA Method 5035 Recommended 5-gram slot positions:

- Use the heavy position for dense clay;
- Use the light position for dry sandy soil; and
- Use the medium position for all others.

2. Collect Sample

Push EasyDraw Syringe™ into a freshly exposed surface of soil until the syringe is full. Continue pushing until the soil column inside the syringe has forced the plunger to the stopping pint. (**Note**: unlike other sample collection devices, there is no headspace air in the syringe to displace.) EasyDraw Syringe™ delivers approximately 5, 10, or 13 grams. Actual weight will be determined at the laboratory. No scale or balance required in the field.

3. Eject Sample Into Vial

Remove the syringe from the Powerstop Handle™ device and insert the syringe into the open end of 40-ml vial, and eject sample into pre-tared vial by pushing on the syringe plunger. Avoid getting dirt on the threads of the 40-ml vial. Cap vial immediately and put on ice. Sample must be received by within 48 hours of sampling if samples are not chemically preserved in the field.

SOP SERIES SAS-07

SEDIMENT SAMPLING AND MEASUREMENT PROCEDURES

STANDARD OPERATING PROCEDURE NO. SAS-07-01

SEDIMENT THICKNESS DETERMINATION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the poling method of determining the thickness of soft sediments. Measurements shall be determined to assist in determining suitability of soft sediment for sample collection and information on the depositional environment in the sample collection location.

2.0 EQUIPMENT AND MATERIALS

- 2-inch diameter graduated aluminum pole or pole sections that can be placed together marked in one-foot increments that are subdivided into one-inch increments;
- Field logbook and/or the appropriate field form(s);
- Decontamination materials;
- Personal protective equipment; and
- Camera.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

The following procedure shall be followed unless otherwise specified by the Site-Specific Work Plan:

1. Maneuver the boat or wade to the sampling location. When wading, take care to minimize disturbance of soft sediment as much as possible by moving slowly.
2. Slowly lower the pole to the sediment surface to avoid disturbance of any flocculent sediment.
3. Stop when slight resistance is encountered, read the pole at the water surface to the nearest inch and record the measurement as the depth to top of sediment from water surface.
4. Push the pole into the sediment until refusal occurs.
5. Read pole at the water surface to the nearest inch and record the measurement as the depth to refusal measurement.
6. Slowly withdraw the pole from the sediment and water to keep sediment disturbance to a minimum.
7. Record any observations, such as type of sediment adhering to the pole and visible signs of contamination.
8. Decontaminate the pole or pole sections in accordance with SOP ENV-04-04.
9. Calculate the soft sediment thickness by subtracting the depth of top of sediment measurement from the depth of refusal measurement and record the calculation and result.

5.0 DOCUMENTATION

Sampling activities shall be documented in the field logbook or on an appropriate field form as outline in SOP ENV-01-01 and/or specified the Site-Specific Work Plan. Visual observations, as discussed above, shall also be recorded in the field logbook or on the field form.

6.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-07-02

DESCRIPTION AND CLASSIFICATION OF SEDIMENTS Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedure for field description and classification of sediments by means of visual inspection and manual testing.

2.0 EQUIPMENT AND MATERIALS

- Field logbook and/or appropriate field forms;
- Pens with waterproof, non-erasable ink;
- Munsell Soil Color Chart, GSA Rock Color Chart, or equivalent;
- Slim stainless-steel spatula or carpenter's 5-in-1 tool;
- Hand lens (optional);
- Camera;
- Decontamination supplies and equipment; and
- Personal protective equipment.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Work on water requires that marine health and safety procedures are used in addition to standard health and safety procedures. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully

understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 SEDIMENT DEFINITIONS

Sediments can be granular or chemical in composition. NOAA (1998) defines granular sediment as material for which percentages of individual components that make up the sediment can be determined by gross or microscopic inspection. Granular sediment can be composed of particulates from three classes of material: biogenic, mineral/lithic, and glass. The glass referred to is volcanic glass and is likely to be present in significant quantities only in areas of active or recent volcanic activity. Since areas with volcanic activity are rare on the North American continent, methods for describing volcanic glass sediments will be determined on a site-specific basis and will not be further discussed in this SOP. Biogenic material is the remains or traces of once-living organisms. Mineral/lithic material is all mineral grains not included in other granular sediment classes. Precipitates and carbonaceous materials occurring in quantities greater than 50 % are classified as chemical sediments and will not be discussed in this SOP.

5.0 GENERAL PROCEDURES

Sediment logging and material classification shall be conducted only by a trained logging technician (e.g. geologist, hydrogeologist, engineer, or environmental scientist). Field data and observations associated with field logging and material classification shall be documented during logging and for all investigation and sampling activities in accordance with SOP ENV-01-01, if not otherwise specified in this SOP. All field drilling activities shall be recorded in a field logbook or on the appropriate field form. In addition, tools and equipment used while logging sediment shall be decontaminated between sampling locations/stations and prior to each sampling event in accordance with the Quality Assurance Project Plan (QAPP).

6.0 SEDIMENT CLASSIFICATION PROCEDURES

6.1 General Classification

Determine if the sediment is primarily biogenic or mineral/lithic. If the sediment contains 30% or more of a single fossil group or 50% or more total biogenic content, classify the sediment as biogenic. This classification cannot always be determined in the field and may require additional microscopic inspection of

the sediment by a paleontologist or biologist. (Note: Classification of types of biogenic sediment beyond general terms of percentage composition and general physical characteristics by visual inspection is outside the scope of this SOP and will not be discussed further.) If the sediment contains mineral/lithic particles in excess of 50% by visual inspection, use a field classification of mineral/lithic.

6.2 Sediment Physical Classification

Classify the sediment sample similarly to soil using the ASTM visual-manual procedure (ASTM D2488-06). (See SOP ENV-05-02, Field Logging and Classification of Soil and Rocks for additional guidance.) If sample is biogenic, some of the following parameters may not apply. Record the following physical parameters, if applicable, in the field logbook or field form:

- Sample color, using Munsell color descriptors and identification numbers, immediately after sample collection;
- Sample color, using Munsell descriptors and numbers, after exposure to the air, if a color change occurs;
- Odor (identify organic odors by particular type if possible [e.g. petroleum-based]);
- Major sediment class (biogenic or mineral/lithic);
- Major mineral/lithic type (e.g. SAND, silty CLAY) or biogenic type (if possible);
- Other granular components and qualitative description of percentage using “with”, “some” or “trace”;
- Particle shape and angularity;
- Any depositional structures (stratification, lamination, etc.)
- Sample consistency;
- Sample grading (sorting) for coarse-grained samples;
- Dry strength, dilatancy, toughness and plasticity for fine-grained samples;
- Evidence of environmental impacts, if encountered (e.g. staining, sheen, or free-phase product) or any foreign materials (brick fragments, manufactured glass, coal fragments, etc.).

7.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2006, D2488-06 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

U.S. Department of Commerce, National Oceanographic and Atmospheric Agency (NOAA) 1998, Proposed NGDC/Curators' Classification for Granular Sediments (Modified from the ODP Sediment Classification Scheme), web address: http://www.ngdc.noaa.gov/mgg/curator/paula1.htm.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-07-03

SEDIMENT SAMPLING Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) presents guidelines for selecting sediment sampling locations and general procedures for the collection of sediment samples. This SOP addresses continental sediments only. Estuarine and oceanic sediment sampling is beyond the scope of this document and will not be discussed. This SOP addresses sample collection for characterization of chemical or physical parameters. Requirements for collection of samples for biological characterization are addressed in a separate SOP.

2.0 EQUIPMENT AND MATERIALS

Sampling equipment and materials vary be collection method. However, some standard equipment and materials are required regardless of collection method:

- Ruler or tape measure in 0.01 –foot increments;
- Sample containers and labels;
- Sample cutting/extracting equipment (scoops, spatulas, trowels, shovels, etc.);
- Field logbook and/or the appropriate field form(s);
- Depth measurement devices;
- Decontamination materials;
- Chain of custody forms;
- Custody seals;
- Coolers and ice packs;
- Personal protective equipment;
- Camera; and
- Global positioning system (GPS) (optional).

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Work on water requires that marine health and safety procedures are used in addition to standard health and safety procedures. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 PERMITTING

Sampling performed within navigable waters and critical habitats may fall under the jurisdiction of one or more federal, state, or local agencies, including by not limited to the United States Army Corp of Engineers (USACOE), US Department of Fish and Wildlife, and state Department of Natural Resources. Prior to the commencement of sampling activities, appropriate permit(s), if applicable, shall be obtained.

5.0 SAMPLE SITE SELECTION

The sediment sampling site will be selected based on a number of factors including among others the presence of environmental impacts on adjacent land, presence of water discharge or outfall area, type of water body (e.g. lake, river, pond, etc.), sediment type, and depth to sediment. In water that is generally navigable, the only requirement for site selection may be ability to access the investigational site by boat. Sediment investigations in rivers, creeks or canals, will usually require additional information for sample site selection including such factors as stream flow velocity; depth, cross section and plan view of stream, and man-made and natural structures that affect stream flow, among others. In many cases, the USACOE and state geological surveys have extensive records for US waters and should be consulted prior to sediment sampling site selection. An experienced geologist or hydrologist should also be consulted prior to site selection.

A pre-sampling site visit is necessary to determine access points and best locations for sampling. Current aerial or satellite photographs of the site may be viewed prior to the initial site visit to obtain a general overview of possible access and sampling locations. Sampling sites may be selected during the site reconnaissance. Sampling locations can be indicated by reference to onshore features, such as buildings, fence lines, trees, etc. If natural features, such as trees are used, they will be marked by paint or colored flags for easy identification. A sketch map will be drawn in the field logbook or on a field form showing reference points and any measurements to be used to locate sampling points. If offshore sites are selected, a GPS can be used to find latitude and longitude coordinates for sampling points. These coordinates will be recorded on a site sampling map or field form, and in the field logbook.

6.0 SEDIMENT SAMPLING EQUIPMENT

Sediment sampling devices will be selected based on depth to sediment, type of sediment, type and size of sample required. Shallow sediment samples can be collected by trowel, scoop or shovel, which is decontaminated before use and between use at each specific sampling location. Manual augering equipment (tube or bucket auger); manual coring devices with Teflon or acetate liners; or barge-mounted machine augering (e.g., hollow-stem) equipment can be used to collect samples. Dredging equipment can be used for larger samples including Peterson, Eckman, and Ponar dredges. Selected sediment sampling methods have been outlined below.

Additionally, a sediment sampling equipment selection table (Attachment A), which was adapted from Ohio EPA, Sediment Sampling Guide (Ohio EPA 2001) and USEPA SOP #2016 – Sediment Sampling provides (USEPA 1994), provides alternative information for selection and use of sediment sampling equipment. The Site-Specific Work Plan will specify the sampling equipment and method(s) to be used. Sampling equipment should be selected to minimize disturbance of potentially impacted sediments.

6.1 Shallow Sediment Sampling Methods

If the water is wadeable, a sediment sample may be collected by scooping the sediment using a stainless steel spoon or scoop, reducing the potential for cross-contamination. This can be accomplished by wading into the stream, and while facing upstream (into the current), scooping the sample along the stream bottom in the

upstream direction. If the stream is too deep to wade but less than eight feet deep, a stainless steel scoop attached to a piece of conduit can be used either from the banks if the stream is narrow or from a boat.

If the stream has a significant flow and is too deep to wade, a BMH-60 sampler may be used. It is not particularly efficient in mud or other soft substrates because its weight will cause penetration to deeper sediments, which are not desired when sampling for priority pollutants. It is also difficult to release secured samples in an undisturbed fashion that would readily permit sub-sampling. The BMH-60 may be used for priority pollutant sampling provided that caution is exercised by only taking sub-samples that have not been in contact with the metal walls of the sampler.

6.2 Core Sampling Methods

Core Sampling Methods are used to sample vertical columns of sediment. They are particularly useful when a historical approach to sediment deposition is desired for they preserve the sequential layering of the deposit. Many types of coring devices have been developed depending on the depth of water from which the sample is to be obtained, the nature of the bottom material, and the length of core to be collected. They vary from hand push tubes to weight or gravity driven devices.

Coring devices are particularly useful in pollutant monitoring because the "shock wave" created by descent is minimal, thus the fines of the sediment-water interface are only minimally disturbed; the sample is withdrawn intact permitting the removal of only those layers of interest; core liners manufactured of glass or Teflon® can be purchased, thus reducing possible sample contamination; and the samples are easily delivered to the lab for analysis in the tube in which they were collected. The disadvantage of coring devices is that a relatively small surface area and sample size is obtained often necessitating repetitive sampling in order to obtain the required amount for analysis. Because it is felt that this disadvantage is offset by the advantages, coring devices are recommended in sampling sediments for trace organic compounds or metals analyses.

Hand / Push Coring Devices may be used in shallow, wade-able waters. This method involves the direct use of a core liner or tube manufactured of Teflon® or glass is recommended for the collection of sediment samples. Their use can also be extended to deep waters when SCUBA equipment is available. Teflon® is preferred to avoid glass breakage and possible sample loss. Stainless steel push tubes are also acceptable and provide a better

cutting edge and higher strength than Teflon®. The use of the glass or Teflon® tube by itself eliminates any possible metal contamination from core barrels, cutting heads, and retainers. The tube should be approximately 12 inches if only recently deposited sediments (8 inches or less) are to be sampled. Longer tubes should be used when the depth of the substrate exceeds eight inches. Soft or semi-consolidated sediments such as mud and clays have a greater adherence to the inside of the tube and thus can be sampled with larger diameter tubes. Because coarse or unconsolidated sediments such as sands and gravel tend to fall out of the tube, a small diameter is required for them. A tube about two inches in diameter is usually the best size. The wall thickness of the tube should be about 1/3 inch for either Teflon® or glass. The inside wall may be filed down at the bottom of the tube to facilitate entry of the liner into the substrate.

Caution should be exercised not to disturb the area to be sampled when the sample is obtained by wading in shallow water. The core tube is pushed into the substrate until only four inches or less of the tube is above the sediment-water interface. When sampling hard or coarse substrates, a gentle rotation of the tube while it is pushed will facilitate greater penetration and cut down on core compaction. The tube is then capped with a Teflon® plug or a sheet of Teflon® held in place by a rubber stopper or cork. After capping, the tube is slowly extracted, the negative pressure and adherence of the sediment keeping the sample in the tube. Before pulling the bottom part of the core above the water surface, it too is capped. With a few modifications, this method can also be applied to sample collection from the edge of a boat or barge.

Vibro-core sampling is described as an electrical powered sediment sampling system featuring a vibrator head that drives a core tube liner into the sediment. Liners, often containing cellulose acetate butyrate (CAB), can be up to 20 feet (6 meters) long and 4 inch inside diameter (ID); lengths are selected based on sediment measured. The sampling vessel should be triple anchored, moored to a secure fixture, or spudded prior to collecting cores. The following procedure is a suggested method to collect sediment core samples:

1. Measure the water depth and soft sediment thickness.
2. Insert core catcher into CAB tube.
3. Position core catcher, drill holes, and rivet into place with aluminum rivets.
4. Lift the vibrating head with the winch to a vertical position so that it is suspended just off the bow of the sampling vessel.
5. Insert the core tube into the vibrating head, making sure that the tube slides in all the way.

6. Tighten the collar to the vibro-core (two bolts on each side).
7. Lower the entire assembly until the core nose is just above the sediment surface. Care should be taken to ensure that the cutter head or end of the core tube does not come into contact with the vessel during deployment. Verify that the generator is on. Turn on the vibrating head.
8. Slowly lower the vibro-core by running out 6-10 inches of cable at a time. Monitor core tube penetration by feeling for slack in the cable. Note appropriate rate of penetration in field log (Appendix B).
9. When the vibro-core ceases to penetrate the sediment (stops lowering or is "refused"), or the vibrating head is near the sediment surface, reverse the winch and pull the unit from the sediment. Do not allow the vibrating head to become imbedded into the sediment.
10. Turn off the power to the vibrating head when the core breaks free of the sediment.
11. During retrieval, the coring device and core tube need to be maintained in a vertical position to minimize disturbance of the collected sediments. Lift the assembly so that the sediment/water interface is visible. Wash the excess sediment from the outside of the tube. Once out of the water, the cutter head should be inspected and a physical description of the material at the mouth of the core entered into the core log. Drill holes through tube at the sediment/water interface and decant water from tube.
12. Tie line around tube in a single or double clove hitch.
13. Disengage the tube and lay the sediment core on the deck. Saw off excess core tube at the sediment surface, and cap the top of the tube with a red cap plug. Both ends should then be secured tightly with duct tape to prevent leakage. The amount of sediment in the tube should be measured and recorded in the sample log, along with the overall condition of the core. The core tube then should be marked to denote: Location, Recovery Length, Top of Core, Date, and Time.
14. Handle and sub-sample core as desired, on board, or at a shore based location.

Ogeechee / Open Barrel Punch Corer. The core unit will be deployed from the sampling vessel by hand to collect an undisturbed sediment sample to a depth of approximately 4 feet below the sediment/surface water interface. The open barrel punch-core will be manned by a minimum of two crewmembers: one staff member or contractor will handle the deployment and retrieval of the core while the vessel operator controls the boat and records the sampling location.

1. Make field notes and logbook entries as necessary throughout the sampling process to ensure thorough and accurate record keeping.
2. Maneuver the boat to the sampling location as identified in the project SSWP or based on field encountered conditions/data.
3. Measure and record the depth to sediment and sediment thickness using poling methods. This information will be used for comparison with any hydrographic survey results.
4. Place the liner (thin-walled tube) inside the core-barrel sampler followed by the core catcher. Open the check valve located atop the core unit. Attach lengths of rod to the core unit to enable the operator to push the core down to the appropriate depth. The rods also allow for the use of weights to help drive the core if needed.
5. Guide the core overboard.
6. Lower the core to the sediment surface at approximately 1.0 feet per second (ft/sec) so as to minimize sediment surface disturbances.
7. Record the location of the boat when sampler reaches bottom.
8. Push or use the weights to drive the sampler to the depth specified in the SSWP or based on field encountered conditions/data.
9. Close the check valve on the barrel core sampler and begin retrieving the sampler, raising it at approximately 1.0 ft/sec.
10. Guide the core on board the vessel and place it on the worktable on the deck; use care to avoid jostling that might disturb the integrity of the sample. Remove the core liner from the barrel.
11. Examine the sample for the following sediment acceptance criteria:
    - The sampler is not overfilled so that the sediment is present in the retrieval rods;
    - No leakage has occurred, as indicated by the presence of sediment at the end of the core tube;
    - No sample disturbance has occurred, as indicated by limited turbidity in the overlying water;
    - If sample acceptance criteria are not achieved, the sample will be rejected and the location re-sampled. If unable to obtain a sample that meets the appropriate acceptance criteria within 50 feet of the proposed location, the sample will be relocated as determined by the Project Manager or Task Manager, as appropriate.
12. Decant or siphon off free water from the surface of the sediment. Care should be taken to not disturb the integrity of the sediment surface. Extrude the sediment from the core liner.

13. Visually classify sediment, record the descriptions on the sediment sampling form, and photograph sample.
14. Repeat the sampling process (if necessary) until sufficient volume is obtained to satisfy the sampling requirements for each location. Collect successive core samples within a radius of 10 feet of the initial sampling location.
15. Handle and sub-sample core as desired, on board, or at a shore based location.

6.3 Dredge Sampling Methods

The Peterson dredge can be used when the bottom is rocky, in very deep water, or when the stream velocity is high. The dredge should be lowered very slowly as it approaches bottom, because it can displace and miss lighter materials if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high velocities. It should not be used from a bridge more than a few feet above the water, because the spring mechanism which activates the sampler can be damaged by the messenger if dropped from too great a height.

The Ponar dredge is a modification of the Peterson dredge and is similar in size and weight. It has been modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing the "shock wave." The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates.

1. Make field notes and logbook entries as necessary throughout the sampling process to ensure thorough and accurate record keeping.
2. Maneuver the boat to the sampling location as identified in the SSWP or based on field encountered conditions/data.
3. Measure and record the depth to sediment and sediment thickness using the poling methods. This information will be used for comparison with any hydrographic survey results.
4. Open the sampler and slide the locking pin into place.

5. Guide the sampler overboard.
6. Lower the sampler to the sediment surface at approximately 1.0 feet per second (ft/sec).
7. Record the location of the boat when sampler reaches bottom.
8. Begin retrieving the sampler and raise it at approximately 1.0 ft/sec.
9. Guide the sampler on board the vessel and place it on the worktable on the deck; use care to avoid jostling that might disturb the integrity of the sample.
10. Examine the sample for the following sediment acceptance criteria:
    - Sampler jaw is closed and the sample does not contain foreign objects
    - Desired penetration depth has been achieved
    - The sampler is not overfilled so that the sediment surface presses against the top of the sampler
    - No leakage has occurred, as indicated by overlying water on the sediment surface
    - No sample disturbance has occurred, as indicated by limited turbidity in the overlying water
    - No winnowing has occurred, as indicated by a relatively flat undisturbed surface
    - If sample acceptance criteria are not achieved, the sample will be rejected and the location re-sampled. If unable to obtain a sample that meets the appropriate acceptance criteria within 50 feet of the proposed location, the sample will be relocated as determined by the Project Manager or Task Manager, as appropriate.
11. Decant or siphon off free water from the surface of the sediment. Care should be taken to not disturb the integrity of the sediment surface.
12. Visually classify sediment, record the descriptions on a sediment sampling form, and photograph sample.
13. Collect the sediment from the sampler using a stainless steel implement and care not to include any material that has been in contact with any interior sampler surface. Place this sediment into an appropriate-sized stainless steel homogenization bowl.
14. Thoroughly rinse the interior of the sampler until all loose sediment has been washed off.
15. Repeat the sampling process (if necessary) until sufficient volume is obtained to satisfy the sampling requirements for each location. Collect successive grab samples within a radius of 10 feet of the initial sampling location.
16. Homogenize the bulk sediment until it has uniform color and texture.
17. Place samples into containers in accordance with SSWP.

18. Clean the exterior of all sample containers and store them in a cooler with ice.

7.0 SAMPLE COLLECTION PROCEDURES

- Prior to mobilization to the field, consult with the contracted analytical laboratory to ascertain if they require any sediment-specific sample collection procedures to be followed to ensure that samples are acceptable for the analyses to be conducted and provided in adequate volume for analyses.
- Sampling locations will be located horizontally using a Global Positioning System (GPS) receiver in the field. Either Real Time Kinematic (RTK), or Differential GPS (DGPS) may be used to achieve sub-foot accuracy.
- Sampling locations will be estimated vertically using a graduated pole in combination with site staff gauge. If a staff gauge has not been established at the site, a staff gauge shall be established and surveyed accurate to ±0.01 feet. Prior to sample collection, a graduated pole will be used to measure the top of sediment relative to surface water. The estimated elevation each sediment sample will be calculated in the office using the surface water elevations measured from the site staff gauge. Measurements shall be collected from the site staff gauge multiple times throughout each day of sampling to account for fluctuating water levels.
- Using a decontaminated sampling instrument, remove the desired thickness and volume of sediment from the sampling location.
- When coring sediments, the penetration depth, recovery depth, and percent recovery shall be recorded on a sediment sampling field form (Appendix B)
- If sediment is not saturated, conduct a direct screening of the sample with a photoionization detector (PID).
- Describe and classify the sample in accordance with SOP ENV-07-02, Description and Classification of Sediments and record observations on a sediment sampling field form (Appendix B).
- **Volatile Organic Compounds (VOCs) –** Discrete sediment samples for VOC analyses will be collected as soon after sample retrieval as possible. Any surface water should be decanted from the sediment before collecting the samples. Pre-preserved vials or jars with Teflon-lined lids will be used if moisture content of soil is too high to allow collection of 5-gram samples for vials. Attachment B provides a detailed sampling procedure for pre-preserved vials. If jars are used, they will be filled to provide zero-headspace samples. Secure container lid, apply label containing sample identification information and place in cooler with ice.

- **Semivolatile Organic Compounds (SVOCs), Metals, Cyanide, PCBs, Pesticides, Herbicides, and Organic Carbon –** Sediment samples for these analytes will be collected after collecting VOCs. Any surface water should be decanted from the sediment before placing it in a container for homogenization. Samples will be homogenized using clean stainless steel mixing bowls, spoons, knifes, etc. Sample aliquots will be placed directly from the sample retrieval device into the stainless steel bowl. The soil will be thoroughly mixed in the bowl to homogenize the sample and then placed directly into appropriate sample containers. Secure container lid, apply label containing sample identification information and place in cooler with ice.
- **Physical Characteristics –** Sediment samples collected for physical characterization should be carefully placed into a large glass jar directly from the sampler to mitigate sample disturbance. Secure container lid, apply label containing sample identification information and place in transportation container.
- Samples shall be identified, labeled, logged, stored and prepared for shipment in accordance with SOP ENV-03-01, Sample Labeling, Logging, Storage and Shipment.
- SOP ENV-03-02 Chain-of-Custody procedures shall be followed in preparing the samples for transport to the analytical laboratory.
- Sampling equipment and tools shall be decontaminated between each sample in accordance with SOP ENV-04-04.
- Containerize any investigation-derived solid and liquid waste, including decontamination water, label and store for disposal at an appropriate disposal facility. Consult with Project Manager regarding disposal of waste.

8.0 DOCUMENTATION

Sampling activities shall be documented as outline in SOP ENV-01-01 and as specified the Site-Specific Work Plan. Visual observations are particularly important and may prove invaluable in interpreting sediment quality study results. Visual observations of affected sediment will use the descriptors from SOP ENV-05-02, Attachment E. These visual observations, including weather and water body conditions during the sampling event, shall also be recorded in the field logbook and/or on the appropriate field form (Appendix B).

9.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2003, D3975-93(2003) Standard Practice for Development and Use (Preparation) of Samples for Collaborative Testing of Methods for Analysis of Sediments.

ASTM International, 2005, D3976-92(2005) Standard Practice for Preparation of Sediment Samples for Chemical Analysis.

ASTM International, 2003, D4823-95(2003)e01 Guide for Core Sampling Submerged, Unconsolidated Sediments.

Ohio Environmental Protection Agency, Division of Surface Water, 2001, Sediment and Sampling Guide and Methodologies, 2nd Ed., November.

USEPA Region V, 1984, Methods Manual for Bottom Sediment Sample Collection, EPA-905-4-004, May.

USEPA, 1994, SOP #2016 – Sediment Sampling, November 17.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

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ATTACHMENT A
SEDIMENT SAMPLING EQUIPMENT SELECTION TABLE

Author: C. Barry **Q2R & Approval By:** J. Gonzalez **Q3R & Approval By:** M. Kelley

SEDIMENT SAMPLING EQUIPMENT SELECTION TABLE[1,2]

Sample Type	Model	Current	Substrate	Remarks
GRAB	Spoon Scoop	Zero To Slight	All	• Use only in relatively calm and shallow water • Relatively little sample disturbance • Simple and inexpensive • Fines may washout when retrieved through water column
CORE	Tube Auger	Zero To Slight	Clay and Silt	• Use only in relatively calm and shallow water • Extension handles can be used for deeper waters. • Relatively little sample disturbance • Simple and inexpensive • Fines may washout when retrieved through water column
CORE	Bucket Auger	Zero To Slight	Clay to Fine Gravel	• Use only in relatively calm and shallow water • Extension handles can be used for deeper waters. • Relatively little sample disturbance • Simple and inexpensive • Fines may washout when retrieved through water column
GRAB	Eckman	Zero To Very Slight	Clay and Silt	• Use in relatively calm water • Pebbles and branches may interfere with jaw closure • Excellent jaw shape and cut • Relatively little sample disturbance • Poor stability – Light weight allows for tendency to "swim" in a current, which sometimes causes miss triggers • 0.02 square meter sample area • Weight with sample is 10 kilograms

[1] Ohio Environmental Protection Agency, Division of Surface Water, 2001, Sediment and Sampling Guide and Methodologies, 2nd Ed., November.
[2] USEPA, 1994, SOP #2016 – Sediment Sampling, November 17.

SEDIMENT SAMPLING EQUIPMENT SELECTION TABLE[1,2] (Continued)

Sample Type	Model	Current	Substrate	Remarks
GRAB	Petite Ponar Peterson	Zero To Very Slight	Clay to Fine Gravel	• Needs relatively calm/sheltered waters • Good stability • Poor jaw shape and cut • Sample disturbance • Less washout if extra weights are used • More cumbersome than an Eckman – Requires a winch • 0.1 – 0.2 square meter sample area • Weight with sample is 30 – 50 kilograms
CORE	Manual	Zero To Strong	Clay to Sand (Inserts needed for sandy samples)	• Recommended for use in shallow water • Deployed by hand or driver (hammer) • Extension handles can be used for deeper waters.
CORE	Coring Tubes	Zero To Moderate	Clay to Sand (Inserts needed for sandy samples)	• Quick and easy • Relatively undisturbed sample • Small sample volume • Samples sometimes compressed
CORE	Gravity	Zero To Moderate	Clay and Silt	• Recommended for rivers • Depths up to 10 meters
CORE	Split Spoon	Zero To Moderate	Clay to Sand (Inserts needed for sandy samples)	• Recommended for use in shallow water • Deployed by hand or driver (hammer) • Vertical profile remains intact and is visible • Point design can reduce sample compaction • Stones can interfere with collection • Equipment is heavy

[1] Ohio Environmental Protection Agency, Division of Surface Water, 2001, Sediment and Sampling Guide and Methodologies, 2nd Ed., November.
[2] USEPA, 1994, SOP #2016 – Sediment Sampling, November 17.

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ATTACHMENT B
ENCORE AND POWERSTOP SAMPLING PROCEDURES

Author:	C. Barry	Q2R & Approval By:	J. Gonzalez	Q3R & Approval By:	M. Kelley

ENCORE™ SOIL SAMPLING PROCEDURE

- Remove EnCore™ sampler and cap from its re-sealable pouch and attach T-handle to sampler body. (**Note**: when dealing with soft or sandy solid, it may be necessary to retract the plunger in the sampler before sample collection.)

- Using the T-handle for leverage, push the sampler into a freshly exposed surface of sediment until the sampler is full.

- Brush any soil off the sampler head and securely attach the sampler cap by pushing with a twisting motion.

- Complete the sample label and attach to the sampler body; place labeled sampler in its re-sealable pouch and seal the pouch.

- Repeat the procedure for two additional samples collected from the same soil stratum or the same area. (**Note:** this step may be eliminated or the number of samples reduced if the suspected level of VOCs is known [i.e., low or high concentration sample]. Consult Method 5035 or discuss procedure with an analytical laboratory for further details.)

- Use a stainless steel spoon or similar tool to collect an additional sample from the same sediment stratum or the same area. Place collected material in a 2-ounce, wide-mouth jar with no preservatives. (**Note:** this additional soil volume is for dry weight and percent moisture determination. This step is not necessary if additional soil from the sample location is collected for other parameter analyses upon which dry weight and percent moisture will be determined.)

- Immediately place samples in a cooler with ice.

  Ship EnCore™ samples (next day priority delivery) to the contract laboratory the day they are collected. Alternatively, arrange to have samples picked-up by the laboratory or delivered to the laboratory by field

personnel within 24 hours of collection. These sample shipment or pickup timelines must be achieved to ensure the laboratory performs sample preservation or analysis within 48 hours of sample collection.

Author:	C. Barry	Q2R & Approval By:	J. Gonzalez	Q3R & Approval By:	M. Kelley

POWERSTOP HANDLE SAMPLING PROCEDURE

1. Load Sampling Device

Insert EasyDraw Syringe™ into the appropriate slot (5 or 10-gram heavy, 5 or 10-gram medium, 5 or 10-gram light or 13 gram position) on the Powerstop Handle™ device and remove end cap from syringe.

EPA Method 5035 Recommended 5-gram slot positions:

- Use the heavy position for dense clay;
- Use the light position for dry sandy soil; and
- Use the medium position for all others.

2. Collect Sample

Push EasyDraw Syringe™ into a freshly exposed surface of soil until the syringe is full. Continue pushing until the soil column inside the syringe has forced the plunger to the stopping pint. (**Note**: unlike other sample collection devices, there is no headspace air in the syringe to displace.) EasyDraw Syringe™ delivers approximately 5, 10, or 13 grams. Actual weight will be determined at the laboratory. No scale or balance required in the field.

3. Eject Sample Into Vial

Remove the syringe from the Powerstop Handle™ device and insert the syringe into the open end of 40-ml vial, and eject sample into pre-tared vial by pushing on the syringe plunger. Avoid getting dirt on the threads of the 40-ml vial. Cap vial immediately and put on ice. Sample must be received by within 48 hours of sampling if samples are not chemically preserved in the field.

SOP SERIES SAS-08

GROUNDWATER SAMPLING AND MEASUREMENT PROCEDURES

STANDARD OPERATING PROCEDURE NO. SAS-08-01

GROUNDWATER AND NON-AQUEOUS PHASE LIQUID MEASUREMENT Revision 1

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe method(s) to measure groundwater, Light Non-Aqueous Phase Liquids (LNAPL) and Dense Non-Aqueous Phase Liquids (DNAPL) elevations and thicknesses in groundwater monitoring wells, observation wells, and recovery wells as required in the Site-Specific Work Plan or as otherwise specified.

2.0 EQUIPMENT AND MATERIALS

- Notebook, field logbook, and/or the field activity form;
- Steel add-on tape or electronic water level indicator;
- Electronic water level indicator;
- Electronic oil/water interface probe;
- Pressure transducer (as appropriate for the conditions);
- Gasket adapted to the diameter of the transducer cable;
- Data logger;
- Decontamination equipment and supplies (in accordance with the guidelines in SOP ENV-04-05).
- Personal protective equipment; and
- Chalk

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read

and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 GENERAL REQUIREMENTS

Water level, LNAPL, and DNAPL (if present) measurements should be obtained at wells designated in the Site-Specific Work Plan. Water level, LNAPL, and DNAPL levels should be measured in referenced to a common elevation or datum, preferably to a USGS benchmark located at the site. Water level, LNAPL, and DNAPL depths should be measured from a reference point marked on the top of the casing, which, in turn, is referenced to a permanent benchmark.

Water and product level measurement devices shall be decontaminated as per SOP ENV-04-05 or as specified in the Site-Specific Work Plan before and after measuring at each location.

Care shall be exercised to avoid direct skin contact while measuring water level and product depth. All equipment should be decontaminated before and after each measurement as per SOP ENV-04-05. Water and product level measurements should be recorded in the field logbook and/or the field activity form.

5.0 MEASUREMENT METHODS AND PROCEDURES

5.1 Discrete Groundwater Level Measurement

Discrete water level measurements should be made by determining the depth to the water surface from the top of the well casing at the fixed reference point. The fixed reference point is established by permanently marking a point on the outer edge (lip) of the well casing. Caution should be exercised so that filings do not fall into the well.

The depth to water can be determined using a steel add-on tape or electronic water level indicator. The steel add-on tape consists of a measuring tape that has 1-foot increments and a 1-foot section at the end of the tape with 0.01-foot increments. The end of the tape is coated with chalk and lowered into the well. The water depth is read from the saturated mark on the chalked tape and added to the depth interval measured at the top of the well casing

Electronic water level indicators are conducting probes that activate an alarm and a light when they intersect the water. The sounder wire is marked in 0.01-foot intervals to indicate depth. All sounders are equipped with weights to maintain line tension for accurate readings. The typical operating procedures for an electronic water level indicator are as follows:

- Lower the sounder wire until it just makes contact with the water in the well and the indicator light goes on or the pulsating alarm is sounded. Record the position of the wire relative to the reference point at the top of the well casing. Record the actual water level reading to the nearest 0.01-foot. Repeat to confirm depth.
- Withdraw the sounder from the well.
- Record the water depth in the field logbook and/or the field activity form.
- Decontaminate the sounder wire and electrode in accordance with SOP ENV-04-05.

Discrete water levels are typically required from a series of wells when data for preparing groundwater contour maps are needed. However, discrete water levels may also be required when monitoring the changes in water level during aquifer testing if aquifer response is sufficiently slow. Continuous water level measurements are discussed in Section 5.4 of this SOP.

5.2 Discrete LNAPL Level Measurement

Discrete LNAPL or product level measurements should be made by determining the depth to the product and water surface from the top of the well casing at the fixed reference point. The fixed reference point is established by permanently marking a point on the outer edge (lip) of the well casing. Caution should be exercised so that filings do not fall into the well.

The depth of the product and water level may be obtained using an electronic oil/water interface probe. An oil/water interface probe has a multi-conducting probe that activates different signals, typically pulsating beeps and continuous alarms, when they intersect the product and water, respectively. The sounder wire is marked in 0.01-foot increments to indicate depth. The interface probe is equipped with a weight to maintain line tension and obtain accurate readings. The typical operating procedures for an electronic oil/water interface probe are as follows:

- Check the interface probe battery by pressing the test button to ensure the device is operating properly before and after taking the level measurement. Daily battery checks should also be made and documented in the logbook.
- Lower the interface probe until it makes contact with the product in the well and the product indicator light goes on or the continuous alarm is sounded. Record the position of the wire relative to the reference point to the nearest 0.01-foot. Repeat to confirm the depth of the product.
- Continue to lower the interface probe, through the product layer, until it makes contact with the water level in the well and the water indicator light goes on or the pulsating alarm is sounded. Record the position of the wire to the reference point to the nearest 0.01-foot. Repeat to confirm the depth of the water.
- Withdraw the probe from the well.
- Record the product and water depth in the field logbook and/or the field activity form.
- Decontaminate the sounder wire and probe in accordance with the guidelines in SOP ENV-04-05.

Alternatively, the depth to the top of LNAPL may be approximated to the tenth of an inch with a weighted standard measuring tape. The thickness of LNAPL will be approximated using a bottom filling, clear, disposable bailer. The bailer may be slowly lowered into the water column, just below the approximate surface and allowed to fill. The bailer will be gently removed from the well to minimize disturbance. Measurements of the observed thickness of LNAPL will be measured to the nearest 0.1-foot using a standard measuring tape and recorded in the field logbook and/or the field activity form.

5.3 Discrete DNAPL Level Measurement

Discrete DNAPL or product level measurements should be made by determining the depth to the product and water surface from the top of the well casing at the fixed reference point. The fixed reference point is established by permanently marking a point on the outer edge (lip) of the well casing. Caution should be exercised so that filings do not fall into the well.

The depth of the water and product level may be obtained using an electronic oil/water interface probe. An oil/water interface probe has a multi-conducting probe that activates different signals, typically continuous alarms and pulsating beeps, when they intersect the water and product, respectively. The sounder wire is

marked in 0.01-foot increments to indicate depth. The interface probe is equipped with a weight to maintain line tension and obtain accurate readings. The typical operating procedures for an electronic oil/water interface probe are as follows:

- Check the interface probe battery by pressing the test button to ensure the device is operating properly before and after taking the level measurement. Daily battery checks should also be made and documented in the logbook.
- Lower the interface probe until it makes contact with the water in the well and the water indicator light goes on or the beeping alarm is sounded. Record the position of the wire relative to the reference point to the nearest 0.01-foot. Repeat to confirm the depth of the water.
- Continue to lower the interface probe, through the water, until it makes contact with the product level in the well and the product indicator light goes on or the continuous alarm is sounded. Record the position of the wire to the reference point to the nearest 0.01-foot. Repeat to confirm the depth to the product.
- Withdraw the probe from the well.
- Record the water and product depth in the field logbook and/or the field activity form.
- Decontaminate the sounder wire and probe in accordance with the guidelines in SOP ENV-04-05.

Alternatively, the measurements of DNAPL may be approximated using a bottom filling, clear, disposable bailer. The bailer may be slowly lowered into the water column, to the bottom of the well and allowed to fill. The bailer will be gently removed from the well to minimize disturbance. Measurements of the observed thickness of DNAPL will be measured to the nearest 0.1-foot using a standard measuring tape and recorded in the field logbook and/or the field activity form.

5.4 Continuous Water Level Measurement

Continuous water level measurements are made by determining the height of the water column above a pressure transducer and electronically recording fluctuations in this height with a data logger. The continuous recording of height of water above the transducer is used for aquifer testing where rapid changes in water level are anticipated. The typical operating procedures for a continuous water level system are as follows:

- Enter the program into a data logger that has fully charged batteries. Alkaline batteries are preferred. During use, the battery voltage should not drop below the minimum voltage specified by the manufacturer; damage to the data logger and loss of recorded data could result.

- Select a pressure transducer for use in a given well that is compatible with both water quality and anticipated pressure sensitivity range (i.e., 5 psi, 30 psi, etc.). The pressure range selected is dictated by the anticipated range in the water column above the transducer and by the desired precision in measurement.
- Connect the transducers to the data logger in the field following manufacturer's instructions. Typically, four to eight input channels are available on the system. Other factors affecting the sampling configuration include cable length; distance between monitored wells; terrain; local human activities (traffic, plant operations); and the ability to secure the system from weather and vandals.
- Attach the transducer cable to the data logger and calibrate in air according to manufacturer's instructions. If multiple data loggers are used, internal clock synchronization should also be performed.
- Measure water level and depth to the bottom of the well before lowering the transducer into the well. Water levels are measured with an electrical water level indicator; total depth of the well is measured with a device compatible with well depth.
- Secure a sanitary fitting (commonly a gasket adapted to the cable diameter) at the surface of the well. Lower transducer into the well through the sanitary fitting to a depth between the water level and the bottom of the well. The transducer must be kept submerged during the period of measurement. Take care to keep the piezometric crystal at the tip of the transducer out of any fine sediment that has accumulated in the bottom of the well. On some transducers, the crystal is protected from sediment intrusion. Measure water level again; record the time indicated on the data logger digital display and water level. From these readings (and other periodic manual water level measurements), the water levels can be converted to elevations.
- Transfer data stored in the data logger periodically to a portable computer. The frequency of data transfer depends on available memory and conditions encountered in the field. Data may be transferred as frequently as daily. If the data logger has a wrap-around memory, the information should be transferred so that records are not recorded over.

6.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

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STANDARD OPERATING PROCEDURE NO. SAS-08-02

LOW-FLOW GROUNDWATER SAMPLING Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures and guidelines for conducting low-flow groundwater sampling. This SOP provides a method that minimizes the impact of the purging process on groundwater chemistry and volume of water for disposal.

2.0 EQUIPMENT AND MATERIALS

- Map of well locations;
- Well construction information;
- Tools and well keys, as required to facilitate access to wells;
- Water level measuring device (electronic water level indicator, interface probe, or weighted steel tape);
- Adjustable rate peristaltic pump or an adjustable rate low-flow submersible or positive displacement bladder pump (Note: The Site-Specific Work and/or Field Sampling Plan (FSP) shall specify the type of pump required);
- 1/4 to 3/8-inch Teflon®, polyvinyl chloride (PVC), or polypropylene tubing;
- Flow measurement supplies (e.g. graduated cylinder and stop watch);
- Power source, if applicable;
- Compressed inert gas source (for use with bladder pump), if applicable;
- Flow-through cell;
- Groundwater quality/indicator parameter monitoring instruments (flow-through cell capable);
- Instrument operation manual(s);
- Instrument calibration standard(s);
- Container(s) for purge water storage (e.g. 5-gallon buckets, polyethylene storage tank, etc.);
- Sample containers and labels, as appropriate for the analytical method(s) selected;
- Field filtration equipment, if applicable;

- Chain of custody forms and seals;
- Cooler(s) with double-bagged ice;
- Polyethylene sheeting, as appropriate;
- Decontamination materials;
- Personal protection equipment; and
- Field logbook and/or appropriate field form.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 APPLICATION OF SAMPLING METHOD

Low-flow is one of several acceptable sampling procedures and may be performed using bladder or peristaltic pumps. Peristaltic pumps may be used when the well depth is less than or equal to fifteen feet, in zones of high contamination, or as approved in a SSWP. The sampling method may be modified to demonstrate attainment of cleanup goals in the future. Low-flow sampling shall not be used when one or more of the following conditions are present:

- Well will not accept or allow placement of the sampling device;
- Non-aqueous phase liquids (NAPLs). Reference SOP SAS-08-07 when sampling wells with NAPL;
- Formation screened will not allow drawdown to stabilize; and
- Water column is less than 2 feet in height.

5.0 EXECUTION

To the extent practical, sampling shall begin at the monitoring well with the least contamination and proceed systematically to the monitoring wells with the most contamination using the procedure outlined in the following subsections unless otherwise required by the Site-Specific Work and/or FSPs.

5.1 Preparation

The sampler shall create a work area around the monitoring well to minimize the potential for cross-contamination. Work area preparations may include the placement of polyethylene sheeting prevent sampling equipment from coming in contact with the ground surface. The sampler shall barricade and/or flag the work area, if required by the Site-Specific HASP. The sampler shall also arrange the sampling equipment and supplies to facilitate efficient execution of groundwater sampling procedures.

5.2 Well Gauging

Groundwater and NAPL, if present, elevation measurements shall be obtained in accordance with SOP SAS-08-01 or as otherwise specified in the Site-Specific Work and/or FSPs. Following sampling, the sampler may obtain the total well depth from top of casing (in feet to the nearest 0.01-foot) using a water level indicator, interface probe, or steel tape, as detailed in SOP SAS-08-05 and as required by the Site-Specific Work and/or FSP or otherwise specified. Measuring the total well depth prior to sampling should be avoided. Total well depths may be obtained following sampling activities or at least two weeks prior to the sampling. If total well depth is required to be measured immediately prior to sampling, the sampler will take precautions to minimize the displacement of sediments, if present, within the well during gauging activities. In general, the use of an interface probe shall be limited to wells containing NAPL or elevated concentrations of constituents of concern. Groundwater and NAPL elevation measurements and total well depth measurements shall be recorded in the field logbook and/or on the appropriate field form.

5.3 Pump/Tubing Intake Positioning

The sampler should determine and place or position the pump/tubing intake as appropriate relative to the position of the water level, screened interval, and constituents of concern. The position the pump/tubing intake should be a minimum of one foot above the well sump to the extent practical and preferably at an elevation near the center of the well screen. The sampler shall slowly raise or lower the pump or tubing when

placing or positioning intake in order to minimize the displacement of sediments, if present, within the well. The pump model/type, tubing (type, inner diameter, and length), and pump/tubing intake depth/elevation shall be recorded in the field logbook and/or on the appropriate field form. If the water quality instruments can be programmed to calculate the one tubing volume, the data collected during pump/tubing intake placement/positioning shall be entered into the instrument. If the instrument cannot be programmed to calculate the tubing volume, this volume shall be calculated by the sampler using the following formula.

$$\text{Tubing Volume}_{(\text{Gallons})} = \text{Tubing Length}_{(\text{Feet})} \times \text{Volume per One Foot of Tubing}^{TDS}_{(\text{Gallons/Foot})}$$

Where: ^{TDS} = Tubing inner diameter-specific; tubing manufacturer provided information.

The calculated tubing volume shall also be recorded in the field logbook and/or on the appropriate field form.

5.4 Equipment Assembly and Calibration

The sampler shall connect the tubing from the well to the inflow fitting at the bottom of the flow-through cell. A length of tubing shall be connected to the outflow fitting at the top of the flow-through cell with the other end extending into a 5-gallon bucket. The 5-gallon bucket shall be used to collect the purge water. Groundwater quality/indicator parameter monitoring instruments will be calibrated in accordance with the instrument operation manual(s) and SOP SAS-02-01 using the manufacturer prescribed calibration standards. During instrument calibration, the instrument shall be set up to measure and record data in the units (e.g. microsiemens per centimeter (uS/cm), milligrams per liter (mg/L), etc.) specified in the Site-Specific Work and/or Sampling Plan(s). Calibration shall be documented in the field logbook and/or on the appropriated field form. Following calibration, the instruments shall be connected to the flow-through cell.

5.5 Flow Rate and Drawdown Determination

The sampler shall re-gauge the depth to groundwater from the top of well casing. The sampler shall turn on the pump at its lowest setting and determine the flow rate by measuring the volume of water removed over a one-minute period using a graduated cylinder and stop watch or other approved flow rate measuring device. The sampler shall monitor the water column drawdown and shall adjust the pump to avoid a drawdown of more than 0.1 meter or 0.3 feet (4 inches). The flow rate of the pump shall generally be adjusted to between 0.2 and 0.5 liters per minute (L/min). During pump start-up, drawdown may exceed 0.3 feet provided the drawdown stabilizes and the groundwater level does not fall below the intake level. The water level shall not

fall below the top of the well screen if the water level was greater than 0.5 feet above the well screen prior to commencing pumping activities. Pump adjustments shall be made within the first 15 minutes of purging. The final flow rate and stabilized drawdown shall be recorded in the field logbook and/or on the appropriated field form.

5.6 Purging and Groundwater Quality/Indicator Parameter Monitoring

The Site-Specific Work and/or FSPs shall specify the groundwater quality/indicator parameters to be monitored, which typically include temperature, pH, specific conductance or actual conductivity, oxidation-reduction potential, dissolved oxygen, and turbidity. Parameter monitoring will begin after a minimum of tubing volume has been purged from the well. The sampler shall monitor and record in the field logbook and/or on the appropriate field form parameters every three to five minutes (during continuous purging) until parameters have stabilized. A generic groundwater sampling field form is provided in Appendix B. Five-minute intervals are typical; three-minute intervals are used during flow rates in highly permeable media that will allow pumping rates that exceed typical low-flow rates. Parameter stabilization is considered to be achieved when three consecutive readings, spaced approximately 2 to 10 minutes, or 0.5 well volumes or more apart, are within the parameter-specific limit listed in the table below or as specified in the Site-Specific Work and/or Sampling Plan(s).

Parameter	**Stabilization Criteria**[1]
Conductance, Specific Electrical	+/- 3% µS/cm @ 25°C
Conductivity, Actual[2]	+/- 3% µS/cm
Dissolved Oxygen	+/- 0.3 mg/L
Oxidation-Reduction Potential	+/- 10 mV
pH	+/- 0.1 standard units
Temperature	+/- 0.1 °C
Turbidity	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs and/or visually clear water

[1] USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA 542-S-02-001
[2] Based on the stabilization criteria for specific electrical conductance as published in the documented cited above

Once the parameters have stabilized, purging is considered complete and sample collection shall commence.

5.7 Sample Collection

While water is being purged from the well, groundwater samples shall be collected directly into the laboratory provided sample containers from the tubing, before the water has passed through the flow-through cell. This shall be accomplished by using a by-pass assemble or disconnecting the flow-through cell to obtain the sample. Water collected for analysis requiring field filtration will be filtered with an in-line Nalgene© disposable 0.45 micron (µm) filter, or equivalent. Water will be discharged directly from the in-line filter into the sample container following a filter pre-rinse, which will be performed by passing water through the filter, minimum of 500 milliliter (mL), and discharging prior to collection of the sample(s). Samples collected with bailers will be collected in intermediated unpreserved laboratory-provided containers and immediately field filtered as previous described with in-line filters.

Samples shall be collected in order of analyte stability, as summarized below, unless otherwise specified by the Site-Specific Work and/or FSPs:

- Volatile organic compounds (VOCs);
- Semi-volatile organic compounds (SVOCs);
- Non-filtered, non-preserved samples (e.g. PCBs, sulfate, etc.);
- Non-filtered, preserved samples (e.g. phenols, nitrogen, cyanide, total metals, etc.);
- Filtered, non-preserved samples;
- Filtered, preserved samples (e.g. dissolved metals); and
- Miscellaneous parameters.

Quality Control (QC) samples, if required, will be collected consecutively to ensure appropriate duplicate sample collection in accordance with SOP SAS-04-03. Immediately following collection, samples shall be placed in an iced cooler.

5.8 Post-Sample Collection

Non-Dedicated and dedicated sampling equipment, which does not remain within the well casing, shall be removed from the monitoring well. The reusable and/or dedicated equipment and instruments shall be decontaminated in accordance with SOP SAS-04-04 or as otherwise specified by the Site-Specific Work and/or Sampling Plan(s). Disposable equipment and supplies shall be disposed of in accordance with procedures outlined in the Site-Specific Work and/or FSPs. The sampler shall secure the well casing using a slip or expandable well cap. The flush-mount lid shall be bolted down or the protective cover closed and locked, as appropriate.

6.0 DOCUMENTATION

Sample information, labeling, and custody control shall be performed in accordance with requirements specified in SOP SAS-03-01 and SAS-03-02. Sampling activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP SAS-01-01 or as required by the Site-Specific Work and/or FSPs. A generic groundwater sampling field form is provided in Appendix B.

7.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Manager, Region 5 and Region 10, EPA 542-S-02-001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-08-03

WELL-VOLUME APPROACH GROUNDWATER SAMPLING Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for obtaining groundwater samples using the well-volume approach from groundwater monitoring wells, recovery wells, or observation wells as described in the Site-Specific Work Plan or as otherwise specified for the purpose of determining groundwater quality. The well-volume approach involves the purging of the stagnant water within the well and stabilization of water quality indicator parameters prior to sampling.

2.0 EQUIPMENT AND MATERIALS

- Map of well locations;
- Tools and well keys, as required to facilitate access to wells;
- Water level measuring device (e.g. electronic water level indicator, interface probe, or weight steel tape);
- Well construction information, as appropriate;
- Calculator / Conversion Chart
- Pump, if required by the Site-Specific Work and/or Field Sampling Plan (FSP);
- Teflon®, polyvinyl chloride (PVC), or polypropylene pump-specific tubing, if applicable;
- Power Source, if applicable;
- Bailer – Disposable (disposable for purging and sampling), PVC (for purging only), and/or stainless steel (for purging and/or sample collection), if required by the Site-Specific Work and/or FSP;
- Rope, if applicable;
- Disposable plastic cups or stainless steel cup;
- Groundwater quality/indictor parameter monitoring instruments;
- Instrument operation manual(s);
- Instrument calibration standard(s);

- Container(s) for purge water volume measurements and storage (e.g. 5-gallon bucket, polyethylene storage tank, etc.);
- Sample containers and labels, as appropriate for the analytical method(s) selected;
- Field filtration equipment, if applicable;
- Chain of custody forms and seals;
- Cooler(s) with double-bagged ice;
- Polyethylene sheeting, as appropriate;
- Personal protective equipment;
- Decontamination materials and supplies;
- Field logbook and/or appropriate field form; and

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 APPLICATION

The well-volume approach is one of several acceptable sampling procedures. The well-volume approach involves the purging of the stagnant water within the well and stabilization of water quality indicator parameters prior to sampling. While this method can be used in wells screened in any formation, it is generally used to sample low-permeability formations (i.e., low-yielding wells).

Newly constructed and developed wells shall be allowed a minimum of 48 to72 hours to stabilize before sampling is performed. Once a well is purged, it should be sampled within 2 hours. If a purged well is

allowed to sit longer than the prescribed 2 hours the water contained in the well casing may no longer be representative of aquifer conditions and the well shall be re-purged with one exception. If a water table well is purged dry, it should be sampled when a sufficient volume of water is present. In general, the sample collection shall take place within 24 hours of bailing or pumping the well dry. Purging a water table well dry should be avoided if possible. Wells screened below the water table should never be purged dry. Purging wells screened across water table must be performed at a rate that prevents significant reduction in the water table elevation. Wells that are purged dry should be sampled at least 2 hours after purging activities. Sampling of wells that are known to contain NAPL will follow procedures in SOP SAS-08-07.

5.0 EXECUTION

To the extent practical, sampling shall begin at the monitoring well with the least contamination and proceed systematically to the monitoring wells with the most contamination using the procedure outlined in the following subsections unless otherwise required by the Site-Specific Work and/or FSPs.

5.1 Preparation

The sampler shall create a work area around the monitoring well to minimize the potential for cross-contamination. Work area preparations may include the placement of polyethylene sheeting prevent sampling equipment from coming in contact with the ground surface. The sampler shall barricade and/or flag the work area, if required by the Site-Specific HASP. The sampler shall also arrange the sampling equipment and supplies to facilitate efficient execution of groundwater sampling procedures.

5.2 Well Gauging

Groundwater and non-aqueous phase liquid (NAPL), if present, elevation measurements shall be obtained in accordance with SOP SAS-08-01 or as otherwise specified in the Site-Specific Work and/or FSP. The sampler shall also obtain the total well depth from top of casing (in feet to the nearest 0.01-foot) using a water level indicator, interface probe, or steel tape, as required by the Site-Specific Work and/or FSP or otherwise specified. Total well depths may be obtained prior to the sampling and provided to the sampler. If total well depth is required to be measured immediately prior to sampling, the sampler will take precautions to minimize the displacement of sediments, if present, within the well during gauging activities. In general, the use of an interface probe shall be limited to wells containing NAPL or elevated concentrations of constituents

of concern. Groundwater and NAPL elevation measurements and total well depth measurements shall be recorded in the field logbook and/or on the appropriate field form.

5.3 Standing Water Column Calculation

The sampler shall calculate the standing water column using the following formula:

Standing Water Column $_{(Feet)}$ = TD $_{(FT\ BTOC)}$ − DTW $_{(FT\ BTOC)}$

Where: TD = Total Well Depth
FT BTOC = Feet below top of well casing
DTW = Depth to Water

The sampler shall record the calculation in the field logbook and/or on the appropriate field form.

5.4 Volume Calculations

The sampler shall calculate the volume of water required to be purged prior to sampling. Depending on data quality objectives, state- or regulatory program-specific requirements, and the Site-Specific Work and/or FSP, one of two methods may be used: casing volume or borehole volume. In general, a minimum of three volumes of water, casing or borehole, shall be purged prior to sample collection (see section 5.6 below) in addition to stabilization of groundwater quality indicator parameters.

5.4.1 Casing Volume Calculation:

The sampler shall calculate the casing volume, which is the volume of water inside the well casing only, using the following formula.

One Casing Volume $_{(Gallons)}$ = Standing Water Column $_{(Feet)}$ X Volume per One Foot of Casing ^{WDS} $_{(Gallons/Foot)}$

Where: ^{WDS} = Well diameter-specific (see table below)

Well Diameter-Specific Volume Per One Foot of Casing				
Well Diameter (Inches)	**Volume Per Foot of Casing (Gallons)**		**Well Diameter (Inches)**	**Volume Per Foot of Casing (Gallons)**
0.25	0.0026		4.0	0.6528
0.50	0.0102		6.0	1.469

Well Diameter-Specific Volume Per One Foot of Casing			
0.75	0.0230	8.0	2.611
1.0	0.0408	10.0	4.081
2.0	0.1632	12.0	5.876

The sampler shall record the calculation in the field logbook and/or on the appropriate field form.

5.4.2 Borehole Volume Calculation

The sampler shall calculate the borehole volume, which is the volume of water inside the well casing and volume of water inside the filter pack, using the following formula. Please note that this calculation requires the sampler to know the borehole diameter, filter pack height/elevation, and filter pack porosity.

One Borehole Volume $_{(Gallons)}$ = n ((A X B) – (A X C)) + (C X D)

Where: n = porosity of the filter pack (generally assumed to be 25% or 0.25)

A = height (in feet) of saturated filter pack

B = borehole diameter-specific volume (see table below)

C = well diameter-specific volume (see table below)

D = standing water column (see Section 5.4.1 above)

Diameter-Specific Volume Per One Foot of Borehole or Casing			
Diameter (Inches)	**Volume Per Foot of Borehole or Casing (Gallons)**	**Diameter (Inches)**	**Volume Per Foot of Borehole or Casing (Gallons)**
0.25	0.0026	4.0	0.6528
0.50	0.0102	6.0	1.469
0.75	0.0230	8.0	2.611
1.0	0.0408	10.0	4.081
2.0	0.1632	12.0	5.876

The sampler shall record the calculation in the field logbook and/or on the appropriate field form.

5.5 Equipment Assembly and Preparation

5.5.1 Pumps

Extreme caution should be exercised to ensure that the equipment does not cause cross-contamination from one well to the next. Therefore, dedicated tubing and pumps are preferred. Peristaltic pumps may be used when the well depth is less than or equal to fifteen feet, in zones of high contamination, or as approved in a SSWP. If it is not practical to dedicate a pump to a specific well, the pump shall be decontaminated in accordance with SOP ENV-04-04. Tubing should always be dedicated and never used for more than one well.

The sampler shall place or position the pump/tubing intake not greater than 6 feet below the dynamic water level in the well and a minimum of one foot above the well sump to the extent practical. Ideally, in non-water table wells, the pump shall be placed within the well screen section. The sampler shall slowly raise or lower the pump or tubing when placing or positioning intake in order to minimize the displacement of sediments, if present, within the well. The pump model/type, tubing (type, inner diameter, and length), and pump/tubing intake depth/elevation shall be recorded in the field logbook and/or on the appropriate field form.

5.5.2 Bailers

Bailers will be used for sampling activities when site-specific work plans provide rational and justification for the use. If a non-dedicated PVC and/or stainless steel bailer(s) is/are used, the bailer(s) must be decontaminated in accordance with SOP ENV-04-04 prior to well purging. The bailer shall be secured using rope to a purge water storage container, protective cover, flush-mount lid, or other object such that the bailer can be retrieved from the well. The rope that will enter the well casing shall not come in with the ground. Bailer samples will be collected using bottom valve sampling devices to limit sample aeration.

5.6 Purging and Groundwater Quality/Indicator Parameter Monitoring

The Site-Specific Work and/or FSP shall specify the groundwater quality/indicator parameters to be monitored, which typically include temperature, pH, specific conductance or actual conductivity, oxidation-reduction potential, dissolved oxygen, and turbidity. Parameter monitoring will begin after a minimum of one volume, casing or borehole (as specified by the Site-Specific Work and/or FSP) has been purged from the well. The sampler shall monitor and record in the field logbook and/or on the appropriate field form

parameters a minimum of every well volume until parameters have stabilized. A generic Groundwater Sampling Field Form is provided in Appendix B. When pumps are utilized for purging, stabilization parameters will be monitored with a flow through cell in accordance with SOP SAS-08-02. Parameter stabilization is considered to be achieved when three consecutive readings, taken every well volume with bailer purging, are within the parameter-specific limit listed in the table below or as specified in the Site-Specific Work and/or FSP and a minimum of three volumes, casing or borehole (as specified by the Site-Specific Work and/or FSP), have been evacuated from the well or the well is purged dry, whichever occurs first. Purging methods are discussed in Sections 5.6.1 and 5.62 below.

Parameter	**Stabilization Criteria**[1]
Conductance, Specific Electrical	+/- 3% µS/cm @ 25°C
Conductivity, Actual[2]	+/- 3% µS/cm
pH	+/- 0.1 standard units
Dissolved Oxygen	+/- 0.3 mg/L
Oxidation-Reduction Potential	+/- 10 mV
Temperature	+/- 0.1 °C
Turbidity	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs and/or visually clear water

Once the parameters have stabilized and a minimum of three volumes, casing or borehole (as specified by the Site-Specific Work and/or FSP), have been evacuated from the well or the well is purged dry, sample collection shall commence (see Section 5.7 below).

5.6.1 Pumps

Following pump/tubing intake placement, the sampler shall commence with purging by turning on the pump. During pumping, intermittently collect pump discharge in a container of known volume for a period of not less than 1 minute to determine the pump flow rate. The approximate pump flow rate shall be documented in the field logbook and/or on the appropriate field form. The sampler shall monitoring groundwater quality/indicator parameters, as described in above, preferably using a flow through cell in accordance with

[1] USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA 542-S-02-001
[2] Based on the stabilization criteria for specific electrical conductance as published in the documented cited above

SOP SAS-08-03. Groundwater quality/indicator parameters shall be recorded in the field logbook and/or on the appropriate field form along with the time and volume of water purged (to the gallon). Periodic measurements of the flow rate will also be recorded during sampling. The evacuated/purged water shall be containerized in an approved storage container as required by the Site-Specific Work and/or FSP.

5.6.2 Bailers

The sampler shall slowly lower and raise the bailer in the well in order to minimize the displacement of sediments, if present, within the well. The sampler shall monitoring groundwater quality/indicator parameters by collecting bailer discharge in a disposable plastic cup, stainless steel cup, or other manner befitting the monitoring instruments (e.g., down-hole probe). Groundwater quality/indicator parameters shall be recorded in the field logbook and/or on the appropriate field form along with the time and volume of water purged. The evacuated/purged water shall be containerized in an approved storage container as required by the Site-Specific Work and/or FSP.

5.7 Sample Collection

5.7.1 Pumps

In general, groundwater samples shall only be collected from adjusted rate peristaltic pumps or adjustable rate low-flow submersible or positive displacement pumps. Groundwater samples shall be collected directly into the laboratory provided sample containers from the tubing, before the water has passed through the flow-through cell. This shall be accomplished by using a by-pass assemble or disconnecting the flow-through cell to obtain the sample. Samples shall be collected in order of analyte stability, as summarized below, unless otherwise specified by the Site-Specific Work and/or FSP:

- Volatile organic compounds (VOCs);
- Semi-volatile organic compounds (SVOCs);
- Non-filtered, non-preserved samples (e.g. Polychlorinated biphenyls (PCBs), sulfate, etc.);
- Non-filtered, preserved samples (e.g. phenols, nitrogen, cyanide, total metals, etc.);
- Filtered (reference SAS-SOP-08-02), non-preserved samples;
- Filtered (reference SAS-SOP-08-02), preserved immediately samples (e.g. dissolved metals); and
- Miscellaneous parameters.

Immediately following collection, samples shall be placed in a cooler with double-bagged ice.

5.7.2 Bailers

In general, groundwater samples shall only be collected from disposable or stainless steel bailers, when pumps are not applicable for sample collection (e.g., low-yielding wells). Groundwater samples shall be collected directly into the laboratory provided sample containers from the bailer. Samples shall be collected in order of analyte stability, as summarized below, unless otherwise specified by the Site-Specific Work and/or FSP:

- VOCs;
- SVOCs;
- Non-filtered, non-preserved samples (e.g. PCBs, sulfate, etc.);
- Non-filtered, preserved samples (e.g. phenols, nitrogen, cyanide, total metals, etc.);
- Filtered (reference SAS-SOP-08-02), non-preserved samples;
- Filtered, (reference SAS-SOP-08-02) preserved samples (e.g. dissolved metals); and
- Miscellaneous parameters.

Immediately following collection, samples shall be placed a cooler with double-bagged ice.

5.7.3 Quality Control Samples

Quality Control (QC) samples, if required, will be collected consecutively to ensure appropriate duplicate sample collection in accordance with SOP SAS-04-03. Immediately following collection, samples shall be placed in a cooler with double-bagged ice.

5.8 Post-Sample Collection

Non-dedicated and dedicated sampling equipment, which does not remain within the well casing, shall be removed from the monitoring well. The reusable and/or dedicated equipment and instruments shall be decontaminated in accordance with SOP SAS-04-04 or as otherwise specified by the Site-Specific Work and/or FSP. Disposable equipment and supplies shall be disposed of in accordance with procedures outlined in the Site-Specific Work and/or FSP. The sampler shall secure the well casing using a slip or expandable

well cap. The flush-mount lid shall be bolted down or the protective cover lid closed and locked, as appropriate.

6.0 DOCUMENTATION

Sample information, labeling, and custody control shall be performed in accordance with requirements specified in SOP SAS-03-01 and SAS-03-02. Sampling activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP SAS-01-01 or as required by the Site-Specific Work and/or FSP. A generic Groundwater Sampling Field Form is provided in Appendix B.

7.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, D4448-01 Standard Guide for Sampling Groundwater Monitoring Wells

ASTM International, D5903-96(2001) Standard Guide for Planning and Preparing for a Groundwater Sampling Event

ASTM International, D6089-97(2003)e1 Standard Guide for Documenting a Ground-Water Sampling Event

ASTM International, D6301-03 Practice for the Collection of Samples of Filterable and Nonfilterable Matter in Water

ASTM International, D6452-99(2005) Standard Guide for Purging Methods for Wells Used for Ground-Water Quality Investigations

ASTM International, D6564-00(2005) Standard Guide for Field Filtration of Ground-Water Samples

ASTM International, D6634-01 Guide for the Selection of Purging and Sampling Devices for Ground- Water Monitoring Wells

ASTM International, D6771-02 Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia, www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Manager, Region 5 and Region 10, EPA 542-S-02-001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-08-04

AQUIFER TESTING Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for field evaluation of aquifer hydraulic conductivity. Variations in the hydraulic conductivity within or between formations or strata can create irregularities in groundwater flow paths. Formations of high hydraulic conductivity represent areas of greater groundwater flow and, therefore, zones of potential preferred contaminant migration. Further, anisotropy within strata or formations affects the magnitude and direction of groundwater flow. Thus, information on hydraulic conductivities is necessary to evaluate preferential flow paths and groundwater velocity.

Hydrogeologic assessments should contain data on the hydraulic conductivities of the significant formations underlying the site as measured in monitoring wells. It may be beneficial to use numerical or laboratory methods to augment results of field tests. However, field methods provide the best definition of the horizontal hydraulic conductivity in most cases. Field methods differ from laboratory methods which measure vertical hydraulic conductivity, typically in Shelby tube samples.

2.0 EQUIPMENT AND MATERIALS

- Pump (and generator if required) capable of withdrawal at a constant or predetermined variable rate that can meet the designed pumpage rate and lift requirements
- Water pressure transducers and data logger (bring transducers for the pumping well and each observation well as well as extras in case of malfunction)
- A flow meter or other type of water measuring device to accurately measure and monitor the discharge from the pumping well
- Sufficient hose or pipe to convey discharge outside the recharge area of the pumping well and observation wells
- Electric water level indicator(s) capable of measurement to the hundredth of a foot
- Watch or stopwatch with second hand

- Barometer (some groundwater multiprobes include a barometer)
- Tape Measure of appropriate length based on distance to observation wells.
- Flashlights, lanterns, alarm clock, electrical tape
- Semi-log graph paper, pens, and field book

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 FIELD METHODS

Varieties of procedures are available for evaluating hydraulic conductivity in the field. ASTM D4043-96(2004) Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques should be consulted in selecting an appropriate test method. Field methods for collecting hydraulic conductivity data are described in a number of ASTM standard practices:

- D2434-68(2000) Test Method for Permeability of Granular Soils (Constant Head)
- D4044-96(2002) Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers
- D4050-96(2002) Test Method (Field Procedure) for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems
- D4104-96(2004) Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests)
- D4105-96(2002) Test Method (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Modified Theis Nonequilibrium Method

- D4106-96(2002) Test Method (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Theis Nonequilibrium Method
- D4511-00 Test Method for Hydraulic Conductivity of Essentially Saturated Peat
- D4630-96(2002) Test Method for Determining Transmissivity and Storage Coefficient of Low-Permeability Rocks by In Situ Measurements Using the Constant Head Injection Test
- D4631-95(2000) Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by In Situ Measurements Using Pressure Pulse Technique
- D5269-96(2002) Test Method for Determining Transmissivity of Nonleaky Confined Aquifers by the Theis Recovery Method
- D5270-96(2002) Test Method for Determining Transmissivity and Storage Coefficient of Bounded, Nonleaky, Confined Aquifers
- D5472-93(2005) Test Method for Determining Specific Capacity and Estimating Transmissivity at the Control Well
- D5473-93(2000) Test Method for (Analytical Procedure for) Analyzing the Effects of Partial Penetration of Control Well and Determining the Horizontal and Vertical Hydraulic Conductivity in a Nonleaky Confined Aquifer
- D5720-95(2002) Practice for Static Calibration of Electronic Transducer-Based Pressure Measurement Systems for Geotechnical Purposes
- D5785-95(2000) Test Method for (Analytical Procedure) for Determining Transmissivity of Confined Nonleaky Aquifers by Underdamped Well Response to Instantaneous Change in Head (Slug Test)
- D5786-95(2000) Practice for (Field Procedure) for Constant Drawdown Tests in Flowing Wells for Determining Hydraulic Properties of Aquifer Systems
- D5850-95(2000) Test Method for (Analytical Procedure) Determining Transmissivity, Storage Coefficient, and Anisotropy Ratio from a Network of Partially Penetrating Wells
- D5855-95(2000) Test Method for (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of a Confined Nonleaky or Leaky Aquifer by Constant Drawdown Method in a Flowing Well
- D5881-95(2005) Test Method for (Analytical Procedure) Determining Transmissivity of Confined Nonleaky Aquifers by Critically Damped Well Response to Instantaneous Change in Head (Slug)
- D5912-96(2004) Test Method for (Analytical Procedure) Determining Hydraulic Conductivity of an Unconfined Aquifer by Overdamped Well Response to Instantaneous Change in Head (Slug)

- D5920-96(2005) Test Method (Analytical Procedure) for Tests of Anisotropic Unconfined Aquifers by Neuman Method
- D6028-96(2004) Test Method (Analytical Procedure) for Determining Hydraulic Properties of a Confined Aquifer Taking into Consideration Storage of Water in Leaky Confining Beds by Modified Hantush Method
- D6029-96(2004) Test Method (Analytical Procedure) for Determining Hydraulic Properties of a Confined Aquifer and a Leaky Confining Bed with Negligible Storage by the Hantush-Jacob Method
- D6030-96(2002) Guide for Selection of Methods for Assessing Groundwater or Aquifer Sensitivity and Vulnerability
- D6034-96(2004) Test Method (Analytical Procedure) for Determining the Efficiency of a Production Well in a Confined Aquifer from a Constant Rate Pumping Test
- D6391-99(2004) Test Method for Field Measurement of Hydraulic Conductivity Limits of Porous Materials Using Two Stages of Infiltration from a Borehole

5.0 SINGLE WELL TESTS

Hydraulic conductivity can be determined in the field using a variety of test methods, each addressing specific conditions, and/or data collection objectives. These methods are commonly referred to as bail down or slug tests and are performed by adding or removing a slug (known volume of water or solid inert material) from a well and observing the recovery of the water surface to its original level. Similar results can be achieved by pressurizing the well casing, depressing the water level, and suddenly releasing the pressure to simulate removal of water from the well. One method is described by McLane, et. al. (1990) and is contained in references to the Standard Practices.

When reviewing information obtained from slug tests, several criteria should be considered. First, they are run on one well and, as such, the information is limited to the geologic area directly adjacent to the screen. Second, the vertical extent of screen will control the part of the geologic formation that the test analyzes. Portions of the geologic formation(s) above or below the screen and sand filter pack and seal intervals may also require separate hydraulic conductivity testing. Third, the methods used to collect single well test data should accurately measure parameters such as changing static water (prior to initiation, during, and following completion of the test), the amount of water removed from the well (or slug volume introduced), and the

elapsed time of recovery. The use of pressure transducers and high speed recording equipment is critical in highly permeable formations.

Observation wells with screens that intersect the water table (i.e. water table wells) will be tested only by methods involving removal of water or a slug from the well in order to minimize the potential for well screen filter pack interference. The addition of water to any monitoring well shall be avoided whenever possible, since the addition may affect water quality in sampling events. When addition of water to a well is unavoidable, the water must be of documentable quality and three times the volume added to the well must be removed immediately upon completion of the test. Addition of water to an observation well is appropriate only to piezometer installation when the dynamic water level is above the well screen and sand filter pack and seal elevations.

Full development of the well screen and filter pack adjacent to the interval under examination, in accordance with SOP SAS-05-04, should be completed following well construction to ensure the removal of fines or correct deleterious drilling effects. Determination of well integrity, SOP SAS-08-05, should be determined prior to performance of the well test.

It is important that slug tests be of sufficient duration to provide representative measures of hydraulic conductivity. Slug tests will range in length from less than a minute to several hours. The time required for a test is a function of the volume of the slug added or removed the formation hydraulic conductivity, and well construction.

Slug tests should be performed at least twice to ensure the accuracy of data collection. General procedures for a slug test are summarized below. The procedures required for a slug test may vary, depending on site-specific-conditions. Modifications to the test procedures will be contained in site-specific work plans.

5.1 Slug Test Procedures with Pressure Transducer and Data Logger

An individual Slug Test Field Form (Appendix B) should be completed for each well tested and should contain at least:

- Project ID - A number assigned to identify a specific site.
- Well ID - The location of the well in which water level measurements are being taken.
- Personnel - The personnel conducting the pumping test.
- Measurement Methods - Type of pump, type of data logger(s) used to record water levels, transducer ID number, and acquisition rate (i.e. data recorded on a log scale). The transducer psi range should be appropriate to the test (e.g. 0 to 5 or 0 to 10 psi).
- Initial Static Water Level (Test Start) - Depth to water, to the nearest 0.01 feet, in the observation well at the beginning of the slug test.
- Slug Withdrawal / Addition Start Time - The date when the test began, and start time using a 24-hour clock.
- Test End Date/Time - The date and time when water level readings were discontinued.
- Final Static Water Level (Test End) - Depth to water, to the nearest 0.01 feet, in the observation well at the end of the slug test.
- Elapsed Time (min) - Time of manual measurement record from time 0.00 (start of test) recorded in minutes and seconds.
- Notes - Appropriate observations or information that has not been recorded elsewhere, including notes on sampling, pH readings, and conductivity readings.

Prior to commencing the slug test, enter site-specific information in the data logger per manufacturer instructions. Store all logger data internally; and on laptop computer and/or portable data key. The data should be transferred to the chosen backup storage device as soon as practical after the test is completed.

Water levels should be measured as specified in the SOP SAS-08-02. Manual measurements are required as a backup to and verification of the data logger(s). It is critical that depth to water readings be measured accurately and the exact time of readings is recorded. Determine the static water level in the well; measure the depth to water periodically for several minutes to several hours, and taking the average of the readings (see SOP SAS-07-02). Record information on the Slug Test Field Form (Attachment B). Additional information should be recorded on the Daily Activity Log in SOP SAS-01-04.

5.2 Slug Test Preparation

- Lower the transducer and cable in the well below the estimated target drawdown depth, ensuring the depth of submergence is within the transducer design range.
- Tape the transducer cable to the exterior of the well casing or protective cover to hold the transducer at a constant depth
- Connect the transducer cable to the data logger.
- Check the transducer accuracy by raising and lowering the transducer and comparing the change in water level from the transducer reading to the distance the transducer is raised or lowered.
- Enter the initial water level and transducer design range into the recording device according to the manufacturer's operating instructions.
- Allow the static water level to equilibrate to within 0.1 feet of the initial water level.

5.3 Slug Test with Transducer Procedure

- Turn the data logger on and begin collecting data points.
- Smoothly lower the slug/bailer into the well and allow the water level to stabilize within 0.1 feet of the initial water level.
- Remove the slug/bailer as quickly and smoothly as practical. A smooth, rapid removal is required as slug test analysis assumes an instantaneous change in volume is created in the well when the slug is removed.
- The moment the volume is removed is time zero. Collect hand measured water level measurements (Table 1) as a data backup and to verify transducer data.
- Continue measuring and recording depth/time measurements until the water level returns to equilibrium conditions or a sufficient number of readings have been made to show a trend on a plot of water level recovery versus the logarithm of time in accordance with the chosen analysis method. Time will range from less than 1 minute to a few hours.
- Repeat the slug test once the static water level has recovered to within 95 % of the original water level.

Table 1: Time Intervals for Measuring Recovery in Slug Test Well

Elapsed Time Since Start or Stop of Test (Minutes)	OR (which ever is greater)	Percent Water Level Recovery (%)	Interval Between Measurements (Minutes)
0-2		0-30	0.1
2-5		30-50	0.5
5-10		50-60	1
10-60		60-70	5
60-120		70-80	10
120-240		80-100	30

5.4 Slug Test with Water Level Meter

This slug test method should only be used if a transducer/data recorder cannot be obtained or are malfunctioning. This method cannot be used for saturated zones with high hydraulic conductivities because stabilization of groundwater will occur rapidly. Slug test data should be recorded on the Slug Test Data form (Attachment B) in accordance with the completion instructions. Follow the same procedures for Slug Test with Transducer with increased data collection frequency.

Table 2: Time Intervals for Measuring Recovery in Slug Test Well

Elapsed Time Since Start or Stop of Test (Minutes)	Interval Between Measurements (Minutes)
0-2	0.1
2-10	0.5
10-30	1
30-60	5
60-120	10
120-240	30

The interpretation of the single well test data should be consistent with the existing geologic information (boring log data). Staff should be aware of initial rapid water level recovery during a slug test may represent drainage of the filter pack material around the well screen. This is of particular concern in wells screened in low hydraulic conductivity formations (e.g. silty clay, shale). These data points should be ignored when selecting the appropriate data points to establish a water level recovery slope.

6.0 MULTIPLE WELL TESTS

Multiple well tests, more commonly referred to as pumping tests, are performed by pumping water from one well and observing the resulting drawdown in nearby wells. Tests conducted with wells screened in the same water-bearing formation provide hydraulic conductivity data. Tests conducted with wells screened in different water-bearing zones furnish information concerning hydraulic communication between units. Multiple well tests for hydraulic conductivity are advantageous because they characterize a greater proportion of the subsurface and thus provide a greater amount of detail. Multiple well tests are subject to similar constraints to those listed above for single well tests. Some additional problems that should have been considered in conducting a multiple well test include: (1) storage of potentially contaminated water pumped from the well system, and (2) potential effects of groundwater pumping on existing waste plumes. The geologic constraints should be considered to interpret the pumping test results. Incorrect assumptions regarding geology may translate into incorrect estimations of hydraulic conductivity.

7.0 LABORATORY METHODS

Laboratory analysis of undisturbed samples (e.g. Shelby tube) provides values of vertical hydraulic conductivity. When laboratory methods are to be used, the specific ASTM Standard Practice shall be referenced in samples provided to subcontractors. ASTM methods shall be consulted to assure that test methods specified are applicable to the sample to be tested.

8.0 CONTROLLED PUMPING TESTS

The most representative method for determining aquifer characteristics is by controlled aquifer pumping tests, because these tests stress a much larger volume of the formation than slug tests and laboratory tests. Pumping tests require a higher level of effort and expense than other types of aquifer tests, and are not always justified.

As an example, slug tests may be acceptable for site characterization, whereas pumping tests may be performed to support remedial design or modeling.

Aquifer characteristics that may be obtained from pumping tests include transmissivity (T), hydraulic conductivity (K), specific yield (Sy) for unconfined aquifers, and storage coefficient (S) for confined aquifers. These parameters can be determined by graphical solutions and computerized programs, such as Aqtesolv®.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required dependent on site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

8.1 Summary

If possible, continuously monitor pre-test water levels at the test site for about one week prior to performance of the pump test. This information allows for the determination of the barometric efficiency of the aquifer, as well as noting changes in head due to recharge or pumping in the area adjacent to the well. Prior to initiating the long-term pump test, a step test (Section 5.5) is performed to estimate the greatest flow rate that may be sustained by the pump well.

After the pumping well has recovered from the step test, the long-term pumping test begins. At the beginning of the test, the discharge rate is set as quickly and accurately as possible. The water levels in the pumping well and observation wells are recorded following a set schedule. The duration of the test is determined by project needs and aquifer properties; typically three days or until water levels becomes constant.

8.2 Interferences and Potential Problems

Prior to conducting a pumping test, efforts should be made to anticipate and resolve interferences and potential problems that could affect the aquifer or the test. These problems could be caused by changing atmospheric conditions, impact of local potable wells, contaminants in the aquifer, etc. Note that if it is necessary for a neighboring well to pump during the test, pumping should commence as early as feasible prior to start of the test at a constant rate and not started or stopped for the duration of the test.

8.3 Pumping Discharge

If a pumping test will be conducted in an area with contaminated groundwater, special arrangements must be made for proper handling, treatment, and disposal of the water. The preferred method is to discharge to a sanitary sewer, with prior approval.

Uncontaminated groundwater discharge generated during a pumping test should be sent to storm or sanitary sewers, abiding by all applicable regulations. If there are no sewers in the vicinity of the pumping well, the discharge may be sent to a river or pond. If the previously mentioned discharge options are not available, the groundwater may be discharged to the ground surface under either of the following conditions:

- The aquifer being tested is confined; or
- The end of the discharge hose/pipe is outside of the cone of depression created by the pumping well when testing an unconfined aquifer.

8.4 Pre-Test Procedures

The hydrostratigraphy of the aquifer should be fully characterized prior to performance of the test to identify formation thickness, whether it is confined or unconfined, whether confining layers are leaky and to identify any lateral boundaries that may influence results.

If the pumping test occurs at a site where existing production and/or monitoring wells will be used, confirm that the locations and screened intervals of the wells are within the same aquifer, and meet the requirements of the method of analysis.

If possible, continuously measure water levels in the pumping well and all observation wells for a period at least equal to the length of the test. Trends should be similar in all wells. A well with an unusual trend may indicate some local stress in the aquifer.

The magnitude of water-level fluctuations due to changes in barometric pressure will change throughout the test and should be adjusted based on the changes in the barometric pressure recorded during the test. Changes in barometric pressure will be recorded during the test in order to correct water levels for any possible

fluctuations that may occur due to changing atmospheric conditions. These barometric changes are used to "correct" water levels during the test so they are representative of the hydraulic response of the aquifer due to pumping of the test well. Ideally, water levels should be measured in a well outside of the cone of depression before, during, and after pumping to determine background changes in water levels during the test and to establish correction factors for the wells within the cone of depression.

8.5 Step Test

The step drawdown test is performed to determine the maximum pumping rate that the pumping well can sustain and the minimum pumping rate necessary to assure drawdown in the observation wells. The pumping and observation wells are equipped with transducers prior to the test. Check the transducer accuracy by raising and lowering the transducer and comparing the change in water level from the transducer reading to the distance the transducer is raised or lowered.. The test is then performed by pumping at a low rate, relative to the expected final rate of pumpage, until drawdown in the pumping well stabilizes. The rate is then increased again until drawdown in the pumping well stabilizes (step 2). A minimum of three steps will be tested; the duration of each step will be similar, and should be between 30 minutes and 2 hours.

The data are then plotted on semi-log paper or on a computer. The maximum sustainable pumping rate that yields drawdown in the closest observation wells will be used as the target-pumping rate for the long-term test. These data may also be used to determine aquifer properties and well loss in the pumping well.

8.6 Pump Test Time Intervals

Commence the long-term pumping test after the pumping well has fully recovered from the step test. Place transducers into the observation wells prior to starting the test and allow time for them to equilibrate to the water temperature within the well and to collect pre-test water level data. At the beginning of the test, the discharge rate should be set as quickly and accurately as possible. Record the pumping and observation well water levels with transducers and a data logger(s) set to record logarithmically. As backup in case of transducer malfunction, manually record water levels on field forms and/or field notebooks according to the schedules in Tables 3 and 4:

Table 3: Time Intervals for Measuring Drawdown in the Pumped Well

Elapsed Time Since Start or Stop of Test (Minutes)	Interval Between Measurements (Minutes)
0-10	0.5-1
10-15	1
15-60	5
60-300	30
300-1440	60
1440-termination	480

Table4: Time Intervals for Measuring Drawdown in an Observation Well

Elapsed Time Since Start or Stop of Test (Minutes)	Interval Between Measurements (Minutes)
0-60	2
60-120	5
120-240	10
240-360	30
360-1440	60
1440-termination	480

For wells with a transducer malfunction, water levels records should be manually recorded on field forms and/or field notebooks according to the schedule in Table 5:

Table 5: Time Intervals for Measuring Drawdown in the Observation Wells with Transducer Malfunction

Elapsed Time Since Start or Stop of Test (Minutes)	Interval Between Measurements (Minutes)
0-2	0.1
2-10	0.5
10-20	1
20-100	5
100-200	10
200-300	30
300-1440	60
1440-termination	480

8.7 Water Level Measurements

Water levels will be measured as specified in the SAS-08-02. During the early part of the test, sufficient personnel are required to initiate the pumping test data loggers and assist with manual water level measurements of the pumping well and flow rate measurements. Manual measurements are required as a backup to and verification of the data logger(s). After the first two hours, one to two people are usually sufficient to continue the test. It is not necessary that readings at the wells be taken simultaneously. It is very important that depth to water readings be measured accurately and the exact time of readings is recorded.

During a pumping test, the following data must be recorded accurately on the log book and/or the aquifer test data form.

- Project ID - A number assigned to identify a specific site.
- Well ID - The location of the well in which water level measurements are being taken.
- Distance and Direction from Pumped Well - Distance and azimuth to each observation well from the pumping well in feet.
- Personnel - The personnel conducting the pumping test.

- Pumping Start and End Date/Time - The date when the pumping began, and start time using a 24-hour clock.
- Initial Static Water Level (Test Start) - Depth to water, to the nearest 0.01 feet, in the observation well at the beginning of the pumping test.
- Test End Date/Time - The date and time when water level readings were discontinued.
- Final Static Water Level (Test End) - Depth to water, to the nearest 0.01 feet, in the observation well at the end of the pumping test.
- Target Pumping Rate
- Measurement Methods - Type of pump, type of data logger(s) used to record water levels, transducer ID number, and acquisition rate (i.e. data recorded on a log scale). The transducer psi range should be appropriate to the test (e.g. 0 to 5 or 0 to 10 psi).
- Notes - Appropriate observations or information that has not been recorded elsewhere, including notes on sampling, pH readings, and conductivity readings.
- Elapsed Time (min) - Time of manual measurement record from time 0.00 (start of test) recorded in minutes and seconds.
- Depth to Water (ft) – Manual depth to water measurement, to the nearest 0.01 feet, in the observation well at the time of the water level measurement.
- Flow Rate (gal/min) - Flow rate of pump measured from an orifice, weir, flow meter, container, or other type of water measuring device.

8.8 Pump Test Duration

The duration of the test is determined by the needs of the project and properties of the aquifer. One simple test for determining adequacy of data is when the log-time versus drawdown for the most distant observation well begins to plot as a straight line on the semi-log graph paper. There are several exceptions to this simple rule of thumb; therefore, it should be considered a minimum criterion. Different hydrogeologic conditions can produce straight-line trends on log-time versus drawdown plots. In general, longer tests produce results that are more definitive. Duration of one to three days is desirable, followed by a similar period of monitoring the recovery of the water level. Unconfined aquifers and partially penetrating wells may have shorter test durations. Knowledge of the local hydrogeology, combined with a clear understanding of the

overall project objectives is necessary in judging appropriate test duration. There is no need to continue the test once the water levels in the observation wells stabilize.

The recovery of water levels following pumping phase may be measured and recorded for a period equal to the pumping phase. The frequency of the water level measurements should be similar to the frequency of water level measurements during the pumping phase (Table 1).

9.0 POST OPERATION

The following activities are performed after completion of water level recovery measurements following a slug or pumping/recovery test:

- Decontaminate and/or dispose of equipment per SAS-04-05.
- When using an electronic data-logger, use the following procedures:
  - Stop logging sequence
  - Check file size, print data, and/or save memory to a reliable storage device (i.e. hard drive or USB drive): Backup the data as soon as possible upon completion of a test!
  - Do not clear the memory of the transducer until the data has been saved onto a hard drive
- Review field forms for completeness.
- Replace testing equipment in storage containers
- Check sampling equipment and supplies. Repair or replace all broken or damaged equipment.
- Interpret slug or pumping/recovery test field results.

10.0 CALCULATIONS

Upload the data from the test into a spreadsheet to be entered into a computerized program, such as Aqtesolv®. Use the information entered into the Data Acquisition Form to complete the computer analysis of the data. There are several accepted methods for determining aquifer properties such as transmissivity, storativity, and conductivity. The appropriate method to use is dependent on the characteristics of the aquifer being tested (confined, unconfined, leaky confining layer etc.). When reviewing slug and pump test data, the following text and/or documents may be used to determine the method most appropriate to your case:

- Analysis and Evaluation of Pumping Test Data (Kruseman and Ridder, 1989)
- Applied Hydrogeology (Fetter, 2000)

- Groundwater and Wells (Driscoll, 1986)
- ASTM D4105-96(2002)
- ASTM D4106-96(2002)

11.0 QUALITY ASSURANCE/ QUALITY CONTROL (QA/QC)

Gauges, transducers, flow meters, and other equipment used in the pumping tests will be calibrated before use at the site. Copies of the documentation of instrumentation calibration will be filed with the test data records. The calibration records will consist of laboratory measurements and, if necessary, any on-site zero adjustment and/or calibration that were performed. Where possible, all flow and measurement meters will be checked on-site using a container of measured volume and stopwatch; the accuracy of the meters must be verified before testing proceeds. For QA/QC purposes, a minimum of two single well tests (slug test) should be performed in each well that hydraulic conductivity testing is performed.

12.0 DATA REDUCTION AND INTERPRETATION

Slug and multiple well test data can be analyzed by a variety of methods, depending on the responses observed, geologic conditions, and specific well parameters. Texts such as Driscoll (1986) or other well hydraulics references should be consulted for selection of the proper method of data analysis. In reviewing hydraulic conductivity measurements, the following criteria should be considered to evaluate the accuracy or completeness of information.

- Values of hydraulic conductivity between wells in similar lithologies should generally not exceed one order of magnitude difference.
- Hydraulic conductivity determinations based upon multiple well tests are preferred. Multiple well tests provide more complete information because they characterize a greater portion of the subsurface.
- Use of single well tests will require that more individual tests be conducted at different locations to sufficiently define hydraulic conductivity variation across the site.
- Hydraulic conductivity information generally provides average values for the entire area across a well screen. For more depth discrete information, well screens will have to be shorter. If the average hydraulic conductivity for a formation is required, entire formations may have to be screened, or data taken from overlapping clusters.

It is important that measurements define hydraulic conductivity both vertically and horizontally across the site. Laboratory tests may be necessary to ascertain vertical hydraulic conductivity in saturated formations or strata. Results from boring logs should also be used to characterize the site geology. Zones of high permeability or fractures identified from drilling logs should be considered in the determination of hydraulic conductivity. Additionally, information from boring logs can be used to refine the data generated by single well or pumping tests.

13.0 REFERENCES AND ADDITIONAL RESOURCES

Bouwer, H., and Rice, R.C., "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with completely or Partially Penetrating Wells", Water Res. Res., 12 p. 423-428, 1976.

Driscoll, F. G., 1986, Groundwater and Wells, Johnson Division, St. Paul, MN, 1089 p.

McLane, G. A., D. A. Harrity, K. O. Thomsen, "Slug Testing In Highly Permeable Aquifers Using a Pneumatic Method", Hazardous Materials Control Research Institute, Conference Proceedings, November, 1990, pp 300-303.

ASTM International, D2434-68(2000) Test Method for Permeability of Granular Soils (Constant Head)

ASTM International, D4043-96(2004) Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques

ASTM International, D4044-96(2002) Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers

ASTM International, D4050-96(2002) Test Method (Field Procedure) for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems

ASTM International, D4104-96(2004) Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests)

ASTM International, D4105-96(2002) Test Method (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Modified Theis Nonequilibrium Method

ASTM International, D4106-96(2002) Test Method (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Theis Nonequilibrium Method

ASTM International, D4511-00 Test Method for Hydraulic Conductivity of Essentially Saturated Peat

ASTM International, D4630-96(2002) Test Method for Determining Transmissivity and Storage Coefficient of Low-Permeability Rocks by In Situ Measurements Using the Constant Head Injection Test

ASTM International, D4631-95(2000) Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by In Situ Measurements Using Pressure Pulse Technique

ASTM International, D5269-96(2002) Test Method for Determining Transmissivity of Nonleaky Confined Aquifers by the Theis Recovery Method

ASTM International, D5270-96(2002) Test Method for Determining Transmissivity and Storage Coefficient of Bounded, Nonleaky, Confined Aquifers

ASTM International, D5472-93(2005) Test Method for Determining Specific Capacity and Estimating Transmissivity at the Control Well

ASTM International, D5473-93(2000) Test Method for (Analytical Procedure for) Analyzing the Effects of Partial Penetration of Control Well and Determining the Horizontal and Vertical Hydraulic Conductivity in a Nonleaky Confined Aquifer

ASTM International, D5720-95(2002) Practice for Static Calibration of Electronic Transducer-Based Pressure Measurement Systems for Geotechnical Purposes

ASTM International, D5785-95(2000) Test Method for (Analytical Procedure) for Determining Transmissivity of Confined Nonleaky Aquifers by Underdamped Well Response to Instantaneous Change in Head (Slug Test)

ASTM International, D5786-95(2000) Practice for (Field Procedure) for Constant Drawdown Tests in Flowing Wells for Determining Hydraulic Properties of Aquifer Systems

ASTM International, D5850-95(2000) Test Method for (Analytical Procedure) Determining Transmissivity, Storage Coefficient, and Anisotropy Ratio from a Network of Partially Penetrating Wells

ASTM International, D5855-95(2000) Test Method for (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of a Confined Nonleaky or Leaky Aquifer by Constant Drawdown Method in a Flowing Well

ASTM International, D5881-95(2005) Test Method for (Analytical Procedure) Determining Transmissivity of Confined Nonleaky Aquifers by Critically Damped Well Response to Instantaneous Change in Head (Slug)

ASTM International, D5912-96(2004) Test Method for (Analytical Procedure) Determining Hydraulic Conductivity of an Unconfined Aquifer by Overdamped Well Response to Instantaneous Change in Head (Slug)

ASTM International, D5920-96(2005) Test Method (Analytical Procedure) for Tests of Anisotropic Unconfined Aquifers by Neuman Method

ASTM International, D6028-96(2004) Test Method (Analytical Procedure) for Determining Hydraulic Properties of a Confined Aquifer Taking into Consideration Storage of Water in Leaky Confining Beds by Modified Hantush Method

ASTM International, D6029-96(2004) Test Method (Analytical Procedure) for Determining Hydraulic Properties of a Confined Aquifer and a Leaky Confining Bed with Negligible Storage by the Hantush-Jacob Method

ASTM International, D6030-96(2002) Guide for Selection of Methods for Assessing Groundwater or Aquifer Sensitivity and Vulnerability

ASTM International, D6034-96(2004) Test Method (Analytical Procedure) for Determining the Efficiency of a Production Well in a Confined Aquifer from a Constant Rate Pumping Test

ASTM International, D6391-99(2004) Test Method for Field Measurement of Hydraulic Conductivity Limits of Porous Materials Using Two Stages of Infiltration from a Borehole

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-08-05

WELL INTEGRITY INSPECTION, MAINTENANCE, AND REHABILITATION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for inspecting groundwater monitoring well integrity. The well integrity inspection identifies wells that in their current condition are not suitable for obtaining groundwater/product elevations, water quality and/or hydraulic information, groundwater/product samples and/or other data obtained using the well. The results of the evaluation shall be used to ensure the integrity of wells over extended periods of time by identifying conditions that warrant well maintenance and/or rehabilitation. This SOP also describes well maintenance and rehabilitation.

2.0 EQUIPMENT AND MATERIALS

- Map of well locations;
- Tools and well keys, as required to facilitate access to wells;
- Water level measuring device (electronic water level indicator, interface probe, or weighted steel tape);
- Adjustable rate pump, adjustable rate submersible or positive displacement bladder pump (Note: The Site-Specific Work and/or Field Sampling Plan (FSP) shall specify the type of pump required);
- 1/4 to 3/8-inch Teflon®, polyvinyl chloride (PVC), or polypropylene tubing, if applicable;
- Power source, if applicable;
- Compressed inert gas source (for use with bladder pump), if applicable;
- PVC or stainless steel bailer or solid slug;
- Rope;
- Pressure transducer and automatic data logger, if applicable;
- Container(s) for purge water storage (e.g. 5-gallon buckets, polyethylene storage tank, etc.);
- Existing well boring/construction logs, if available;
- Groundwater elevation table, if available;
- Polyethylene sheeting, as appropriate;

- Camera;
- Personal protection equipment; and
- Field logbook and/or appropriate field forms.

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

Inspections shall be performed at the frequencies described below or as required by the Site-Specific Work Plan to 1) verify the structural integrity of the wells above and below ground, 2) identify significant silt/sediment buildup in wells, and 3) identify biofouling that could contribute to corrosion of structures or decrease in the efficiency of recovery and pumping operations.

4.1 Well Location Verification

The location of each well shall be compared to that given on the site map. If the well location is found to be in error, the well shall be resurveyed and/or re-delineated relative to site features and its position adjusted on the map.

4.2 Aboveground Structural Integrity Inspection

The physical condition of the well will be determined by visually inspecting aboveground components during each monitoring and/or sampling event. Components to be inspected include:

- Protective casing/flush-mount cover;
- Bumper posts, if applicable;
- Concrete pad or apron, if applicable;
- Well cap (expandable or slip);
- Locking mechanism;
- Exposed top of casing; and
- Surface drainage around the wells.

If the aboveground components are damaged, well maintenance or rehabilitation is required (see Section 4.3).

4.3 Below Ground Well Structural Integrity Inspection

4.3.1 General

Total depth measurements shall be obtained annually in accordance with SOP ENV-08-01 and compared to the baseline total depth measurements obtained at the time of well installation, development, and/or start of the project. If a significant amount of silt/sediment is present, well maintenance or rehabilitation is required (see Section 4.4). Additionally, single well aquifer testing may be performed to determine if silt/sediment has decreased the well hydraulic conductivity, indicating well maintenance or rehabilitation is necessary for collection of representative data. Use of this test will be determined on a site-specific basis or as otherwise determine in the SSWPs.

4.3.2 Monitoring Wells

A stainless steel or PVC bailer or slug, with a diameter and length equivalent to a sampling pump or bailer, shall be lowered the entire length of the well to identify obstructions or damage to the well casing and screen. If the bailer or slug cannot be lowered to within the screened interval, an obstruction or damage exists that requires well maintenance or rehabilitation (see Section 4.4). If well yield decreases significantly, well

integrity may be assessed using a single well aquifer test to determine if well maintenance or rehabilitation is required.

4.3.3 Vapor Extraction Wells

Vacuum and air flow rates shall be measured periodically in accordance with system-specific procedures and compared to previous steady-state measurements and the current operational status of the system. If a significant change in vacuum and/or air flow rates is observed and not substantiated by the current operational status of the system, well maintenance or rehabilitation is required (see Section 4.4).

4.3.4 Recovery Wells

Recovery rates shall be evaluated at least once every quarter and compared to previous measurements. If a significant change in rates is observed and not substantiated by current product/water levels, well maintenance or rehabilitation is required (see Section 4.4).

4.4 Well Maintenance or Rehabilitation

Deficiencies or damage identified during aboveground and below ground well integrity inspections shall be evaluated on a case-by-case basis. Well maintenance or rehabilitation that cannot be implemented at the time of inspection shall be implemented within a reasonable period of time. Well maintenance or rehabilitation may include, but is not limited to, the following:

- Replacement of aboveground components;
- Silt/sediment removal;
- Well surging and redevelopment;
- Biomass removal and/or cleaning with an approved biocide; and
- Equipment (e.g. pumps, etc.) repair or replacement.

If deficiency or damage cannot be corrected through well maintenance or rehabilitation, the well shall be abandoned in accordance with SOP ENV-05-05 and applicable federal, state, and local regulations. Wells critical to site activities and/or operations shall be replaced in accordance with SOPs ENV-05-03 and ENV-05-04, applicable federal, state, and local regulations, and the Site-Specific Work Plan.

4.5 Decontamination

Non-Dedicated and dedicated equipment used for inspection and/or corrective action activities, which does not remain within the well casing, shall be removed from the well. The reusable and/or dedicated equipment and instruments shall be decontaminated in accordance with SOP ENV-04-04 or as otherwise specified by the Site-Specific Work Plan. Disposable equipment and supplies shall be disposed of in accordance with procedures outlined in the Site-Specific Work Plan.

5.0 DOCUMENTATION

Inspection, maintenance, and rehabilitation activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP ENV-01-01 or as otherwise required by the Site-Specific Work Plan.

6.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, D6089-97(2003) Standard Guide for Documenting a Ground-Water Sampling Event

ASTM International, D4448-01 Standard Guide for Sampling Groundwater Monitoring Wells

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia, www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-08-07

NON-AQUEOUS PHASE LIQUID SAMPLING Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the collection of non-aqueous phase liquid (NAPL) samples from monitoring, observation, and/or recovery wells. NAPL samples are collected to support plume characterization and/or treatment/recovery system design. Light and dense NAPL, also referred to as LNAPL and DNAPL, may be collected for physical parameter determination (e.g. density, viscosity, etc.), simulated distillation, fingerprinting, waste characterization, etc.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials may vary based on the type of NAPL being sampled (light or dense). In general, the following equipment and materials shall be required unless otherwise specified by the Site-Specific Work and/or Field Sampling Plan (FSP):

LNAPL Sample Collection:

- Bailer (disposable or dedicated);
- Rope;
- Peristaltic pump;
- Polyvinyl chloride or Teflon tubing (disposable or dedicated), as appropriate; and
- Silicone tubing (disposable or dedicated).

DNAPL Sample Collection:

- Solinst Model 425 Discrete Interval Sampler or equivalent;
- Low density polyethylene (LDPE) tubing;
- Solinst Reel or equivalent;
- High pressure hand pump or compressed air source with regulator; and
- Rope.

General:

- Water and NAPL gauging equipment (see SOP ENV-08-01);
- 5-gallon bucket;
- Approved storage container(s) (55-gallon drum, polyethylene tank, etc.);
- Sample containers and labels;
- Chain of custody forms and seals;
- Decontamination materials/equipment;
- Personal protective equipment; and
- Field logbook and/or appropriate field form.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

4.1 Preparation

The sampler shall create a work area around the monitoring well to minimize the potential for cross-contamination. Work area preparations may include the placement of polyethylene sheeting prevent sampling equipment from coming in contact with the ground surface. The sampler shall barricade and/or flag the work area, if required by the Site-Specific HASP. The sampler shall also arrange the sampling equipment and supplies to facilitate efficient execution of NAPL sampling procedures.

4.2 Well Gauging

Groundwater and NAPL elevation measurements shall be obtained in accordance with SOP ENV-08-01 or as otherwise specified in the Site-Specific Work and/or FSP. Following sampling activities, the sampler shall also obtain the total well depth from top of casing (in feet to the nearest 0.01-foot) using a water level indicator, interface probe, or steel tape, as required by the Site-Specific Work and/or FSP or otherwise specified. Total well depths may be obtained prior to the sampling (at least one to two weeks in advance) and provided to the sampler. Groundwater and NAPL elevation measurements and total well depth measurements shall be recorded in the field logbook and/or on the appropriate field form.

4.3 Standing NAPL Column and Casing Volume Calculations

The sampler shall calculate the standing NAPL column and casing volume using the following formulas:

4.3.1 LNAPL Column

Standing LNAPL Column $_{(Feet)}$ = DTW $_{(FT\ BTOC)}$ – $DTP_{L\ (FT\ BTOC)}$

Where: DTW = Depth to Water
FT BTOC = Feet below top of well casing
DTP_L = Depth to Product (LNAPL)

4.3.2 DNAPL Column

Standing DNAPL Column $_{(Feet)}$ = TD $_{(FT\ BTOC)}$ – $DTP_{D\ (FT\ BTOC)}$

Where: TD = Total Well Depth
FT BTOC = Feet below top of well casing
DTP_D = Depth to Product (DNAPL)

4.3.3 Casing Volume

Casing Volume $_{(Gallons)}$ = Standing NAPL Column $_{(Feet)}$ X Volume per One Foot of Casing ^{WDS} $_{(Gallons/Foot)}$

Where: ^{WDS} = Well diameter-specific (see table below)

Well Diameter-Specific Volume Per One Foot of Casing			
Well Diameter (Inches)	Volume Per Foot of Casing (Gallons)	Well Diameter (Inches)	Volume Per Foot of Casing (Gallons)
0.25	0.0026	4.0	0.6528
0.50	0.0102	6.0	1.469
0.75	0.0230	8.0	2.611
1.0	0.0408	10.0	4.081
2.0	0.1632	12.0	5.876

The sampler shall recorded calculations in the field logbook and/or on the appropriate field form.

4.4 Bailer/Tubing/Sampler Intake Position Determination

The sampler should determine the position/depth of the bailer/tubing/sampler intake, using the water and NAPL elevation measurements, such that the intake will be positioned within the bottom quarter of the NAPL column. The intake position (depth/elevation) shall be recorded in the field logbook and/or on the appropriate field form. In addition, the sampling equipment shall also be recorded in the field logbook and/or on the appropriate field form.

4.5 Well Evacuation

In order to obtain a representative NAPL sample from an existing well, the product that has stagnated and/or may have chemically changed in the well casing shall be removed prior to sampling. The evacuation will allow fresh NAPL to enter the well from the formation.

4.5.1 LNAPL Evacuation

If using a bailer, the sampler shall slowly lower the bailer to the intake position. The bailer shall be slowly retrieved from the well and the contents emptied into a 5-gallon bucket or an approved storage container. This process shall continue until no measurable amount (< 0.01 foot) of LNAPL remains or one casing volume of LNAPL has been removed, whichever occurs first. If using a peristaltic pump, the sampler shall

slowly lower the tubing to the intake position. The pump shall be turned on and the removed LNAPL shall be collected in a 5-gallon bucket or an approved storage container. The pump process shall continue until no measurable amount (< 0.01 foot) of LNAPL remains or one casing volume of LNAPL has been removed, whichever occurs first.

The volume of LNAPL evacuated from the well shall be recorded in the field logbook and/or on the appropriate field form.

4.5.2 DNAPL Evacuation

The discrete interval sampler shall be connected to the tubing and reel. The high pressure hand pump or compressed air shall be connected to the reel. The sampler shall be pressured to the recommended operating pressure for the intake position/depth according to the following unless otherwise specified by the sampler operations manual and/or Site-Specific Work and/or FSP.

Recommended Operating Pressure[1]			
Depth		**Pressure**	
Feet	**Meters**	**psi**	**kPa**
25	8	20	148
50	15	30	217
100	30	50	364
200	61	95	670
300	90	140	952
500	150	225	1,495

Notes: 1. Operating pressure = (Sample depth in feet X 0.43) + 10 psi

2. Operating pressure = (Sample depth in meters X 9.8) + 70 kPa

3. psi = pounds per square inch

4. kPa = kiloPascals

[1] http://www.groundwatersoftware.com/Equipment/solinst_model_425.htm

While pressurized, the sampler shall then be lowered to the intake position/depth. At the desire depth, the pressure shall be released, which will allow the sampler to fill by hydrostatic pressure. The sampler shall then be re-pressurized to the recommended operating pressure. Following, re-pressurization, the sampler shall be slowly raised to the surface. The contents shall be transferred to the 5-gallon bucket or approved storage container via the sample release device. This process shall continue until no measurable amount (< 0.01 foot) of DNAPL remains or one casing volume of DNAPL has been removed, whichever occurs first.

4.6 Post NAPL Evacuation Activities

Groundwater and NAPL elevation measurements shall be measured and monitored in accordance with SOP ENV-08-01 or as otherwise specified in the Site-Specific Work and/or FSP. Once the NAPL column has recovered to a level equivalent or greater than the prescribed sample volume, sampling may commence.

4.7 Sample Collection

4.7.1 LNAPL Sample Collection

If using a bailer, the sampler shall slowly lower the bailer to the intake position. The bailer shall be slowly retrieved from the well and the contents emptied into the appropriate sample container(s).

If using a peristaltic pump, the sampler shall slowly lower the tubing to the intake position. The pump shall be turned on and the removed LNAPL shall be emptied into the appropriate sample container(s).

4.7.2 DNAPL Sample Collection

The discrete interval sampler shall be connected to the tubing and reel. The high pressure hand pump or compressed air shall be connected to the reel. The sampler shall be pressured to the recommended operating pressure for the intake position/depth according to the following unless otherwise specified by the sampler operations manual and/or Site-Specific Work and/or FSP (see Section 4.5.2). While pressurized, the sampler shall then be lowered to the intake position/depth. At the desire depth, the pressure shall be released, which will allow the sampler to fill by hydrostatic pressure. The sampler shall then be re-pressurized to the recommended operating pressure. Following, re-pressurization, the sampler shall be slowly raised to the

surface. The contents shall be transferred to the appropriate sample container(s) via the sample release device.

4.8 Post Sample Collection

Non-Dedicated and dedicated sampling equipment, which does not remain within the well casing, shall be removed from the monitoring well. The reusable and/or dedicated equipment and instruments shall be decontaminated in accordance with SOP ENV-04-04 or as otherwise specified by the Site-Specific Work and/or FSP. Disposable equipment and supplies shall be disposed of in accordance with procedures outlined in the Site-Specific Work and/or FSP. The sampler shall secure the well casing using a slip or expandable well cap. The flush-mount lid shall be bolted down or the protective cover lid closed and locked, as appropriate.

5.0 Documentation

Sample information, labeling, and custody control shall be performed in accordance with requirements specified in SOP ENV-03-01 and ENV-03-02. Sampling activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP ENV-01-01 or as required by the Site-Specific Work and/or FSP.

6.0 REFERENCES AND ADDITIONAL RESOURCES

http://www.groundwatersoftware.com/Equipment/solinst_model_425.htm

USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Manager, Region 5 and Region 10, EPA 542-S-02-001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

SOP SERIES SAS-09

SURFACE WATER SAMPLING AND MEASUREMENT PROCEDURES

STANDARD OPERATING PROCEDURE NO. SAS-09-01

SURFACE WATER SAMPLING FOR CHEMICAL AND BIOLOGICAL ANALYSIS Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the collection of grab surface water samples for chemical and biological analysis using manual sampling techniques. The collection of composite surface water samples using automatic samplers shall be address in an equipment-specific SOP or the Site-Specific Work Plan, as needed. Surface water samples are utilized for the characterization of surface water and assessment of human and ecological receptors.

2.0 EQUIPMENT AND MATERIALS

Sampling equipment and materials vary by collection method. However, some standard equipment and materials are required regardless of collection method:

- Hip or chest waders, as appropriate;
- Boat and personal floatation devices (PFDs), as needed;
- Sample bottles/containers and labels;
- Field logbook and/or the appropriate field form(s);
- Pens with waterproof, non-erasable ink;
- Chain of custody forms;
- Depth and length measurement devices;
- Survey stakes, flags, or buoys and anchors;
- Decontamination materials;
- Coolers and ice packs/double-bagged ice;
- Personal protective equipment; and
- Camera.

3.0 HEALTH AND SAFETY WARNINGS

Aquatic environments present unique health and safety concerns ranging from accessibility to water depth and velocity to indigenous species. Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Work on water requires that marine health and safety procedures are used in addition to standard health and safety procedures. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 PERMITTING

Sampling performed within navigable waters and critical habitats may fall under the jurisdiction of one or more federal, state, or local agencies, including by not limited to the United States Army Corp of Engineers (USACOE), US Department of Fish and Wildlife, and State Departments of Natural Resources. Prior to the commencement of sampling activities, appropriate permit(s), if applicable, shall be obtained.

5.0 EXECUTION

5.1 General Considerations

The scope or extent of the sampling effort, data quality objectives, type(s) of samples (e.g. surface or depth grab), and sampling technique shall be determined prior to sample site selection and sample collection. In addition, the hydrology and morphometrics of a stream or impoundment shall be determined to the extent practical prior to sample collection. Water quality data (e.g. dissolved oxygen, pH, and temperature, etc.) shall be collected prior to sample collection, to the extent practical, to determine if stratification is present. These sampling activities should be restricted to seasons when ice is not present, unless specified by a Site-Specific Work Plan and/or Field Sampling Plan (FSP). The Site-Specific Work Plan and/or FSP, as appropriate, shall specify the type(s) of samples to be collected and the collection technique(s).

5.2 Sample Site Selection

An initial reconnaissance shall be performed, to the extent practical, identify suitable sampling locations. Bridges and piers shall generally be deemed acceptable sampling locations since they provide ready access and permit water sampling at any point across the width of the water body. However, data quality objectives (DQOs) must be reviewed prior to final acceptance of these structures as sampling locations, since these structures alter the nature of water flow. When samples will be collected by wading in lakes, ponds, and slow-moving rivers and streams, sampling locations shall be selected that allow the sampler to approach the location from downstream in order to minimize the disturbance of sediments. Sampling station locations shall be selected without regard to other means of access if the stream is navigable by boat. However, other factors including but not limited to the following shall be considered in the sample site selection process:

- Project goals and DQOs;
- Field personnel health and safety;
- Manmade structures that alter the nature of water flow and mixing;
- General water environment characteristics (e.g. flow, depth, stratification, etc.);
- Potential disturbance of threatened or endangered species or critical habitat; and
- Type of water environment: river, streams, creeks; lakes, ponds, impoundments, estuarine, etc.

5.3 Surface Grab Sample Collection Procedures

Surface grab samples shall be collected from the top 12 inches of the water column. Samples shall be collected in a manner that avoids skimming of the surface and disturbance of sediments. If sample collection is performed by wading in the stream, the location shall be approached from a downstream location and efforts shall be made to minimize sediment disturbance, which has the potential to bias the sample. Wading shall be deemed acceptable if a noticeable current is present and the samples can be collected directly into the bottle from a location upstream of the field personnel. The field personnel shall approach the sample location slowly from downstream in order to minimize sediment disruption and sample corruption.

5.3.1 Direct Grab Sampling

Where practical, use of the actual sample container as the collection device is preferred since the same container can be submitted for laboratory analysis. This procedure reduces sample handling and potential loss of analytes or contamination from the sample from other sources. The following procedure shall be used for direct grab sample collection using unpreserved sample containers:

1. Remove the container cap or lid.
2. Slowly submerge the container, opening first, into the water.
3. Invert the container so the opening is upright and pointing towards the direction of water flow (if applicable) and allow water to slowly run into and fill the container.
4. Return the filled container to the surface.
5. If field preservation is required, proceed to Step 6; otherwise, secure the container cap or lid and proceed to Step 10.
6. Pour out a small volume of sample away from and downstream of the sampling location. (Do not use this step for volatile organics or other analytes that require zero headspace.)
7. Add the appropriate volume of the analytical method-prescribed preservative and secure the container cap or lid.
8. Invert the container several times to ensure sufficient mixing of the sample and preservative.
9. Check the preservation of the sample; adjust the pH of the sample with additional preservative, if necessary; and re-secure the cap or lid.
10. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.3.2 Sampling with an Intermediate Vessel or Container

If the sample cannot be collected directly in the sample container(s), an unpreserved sample container or an intermediate vessel (e.g. beaker, bucket, or dipper with or without an extension arm) shall be used to obtain the sample using the following procedure:

1. Decontamination the intermediate vessel in accordance with SOP ENV-04-04 or use certified clean, laboratory provided, unpreserved bottles.
2. Fill the intermediate vessel or container by slowly dipping it into the water with the opening pointing towards the direction of water flow (if applicable);

3. Allow water to slowly run into and fill the intermediate vessel or container in a manner that minimizes agitation of the sample;
4. If field preservation is required, ensure the preservative is present in the sample container prior to transfering water from the intermediate vessel;
5. Remove the sample container lid and fill the sample container(s) from the intermediate vessel or container while avoid direct contact between them;
6. Secure the sample container lid.
7. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.3.3 Sampling with a Pump and Tubing

The following procedure shall be used for the collection of a surface grab sample using a pump and dedicated tubing:

1. Decontaminate the pump in accordance with SOP ENV-04-04, as appropriate.
2. Lower the tubing or pump intake to a depth of 6 to 12 inches below the water surface, where possible. The pump intake or intake tubing shall be maintained below the water surface during sample collection.
3. Pump several tubing volumes through the system prior to collecting the first sample.
4. If field preservation is required, ensure the preservative is present in the sample container prior to filling the sample container;
5. Fill the sample container(s) from the discharge tubing.
6. Secure the sample container lid.
7. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.4 Depth Grab Sample Collection Procedures

Depth grab samples shall be collected from at least below the top 12 inches of the water column to within 6 inches of the stream or impoundment bed, at depths to satisfy the DQOs specified by a Site-Specific Work Plan and/or determined in the field based on field encountered conditions (i.e., stratification, water column depth, etc.). Specific sample collection procedures for depth grab samples are presented below. If sample collection is performed by wading in the stream, the location shall be approached from a downstream location

and efforts made to minimize sediment disturbance, which has the potential to bias the sample. Wading shall be deemed acceptable if a noticeable current is present and the samples can be collected from a location upstream of the field personnel. The field personnel shall approach the sample location slowly from downstream in order to minimize sediment disruption and sample corruption.

5.4.1 Sampling with Kemmerer, Niskin, or Van Dorn Type Devices

To the extent practical, devices constructed of stainless steel or Teflon or with Teflon-coated surfaces shall be used. Samplers that are constructed of plastic and rubber shall not be used to collect samples for extractable organics or volatile organic compound (VOC) analysis. The following procedure shall be used to collect depth grab samples using these devices:

1. Decontaminate the device in accordance with SOP ENV-04-04;
2. Measure the water column to determine the maximum depth and sampling depths;
3. Mark the line attached to the device with depth increments so that the sampling depth can be accurately recorded;
4. Slowly lower the device to the desired sampling depth in a manner that minimizes sediment disturbance;
5. At the desired depth, send the messenger weight down to trip the closure mechanism;
6. Slowly retrieve the device;
7. Rinse the outside of the device with distilled water;
8. Remove the sample container cap or lid and fill the container via the discharge tube;
9. If field preservation is required, follow Step 6 through Step 9 in Section 5.3.1 above; otherwise, proceed to Step 10 below.
10. Secure the sample container lid.
11. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.4.2 Sampling with Double Check-Valve Bailers

If DQOs do not necessitate a sample from a strictly discrete interval of the water column, a double check-valve bailer may be used. The following procedure shall be used to collect a depth grab sample with a double check-valve bailer:

1. Decontaminate the bailer in accordance with SOP ENV-04-04, or use a clean disposable bailer at each sampling location.
2. Measure the water column to determine the maximum depth and sampling depths.
3. Mark the line attached to the bailer with depth increments so that the sampling depth can be recorded.
4. Slowly lower the bailer to the desired sampling depth in a manner that minimize sediment disturbance.
5. Slowly retrieve the bailer.
6. Rinse the outside of the bailer with distilled water.
7. Remove the sample container cap or lid and fill the containers via the discharge port.
8. If field preservation is required, follow Step 6 through Step 9 in Section 5.3.1 above; otherwise, proceed to Step #9 below.
9. Secure the sample container lid.
10. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.4.3 Sampling with a Pump and Tubing

The following procedure shall be used for the collection of a depth grab sample using a pump and dedicated tubing:

1. Decontaminate the pump in accordance with SOP ENV-04-04, as appropriate.
2. Measure the water column to determine the maximum depth and sampling depths.
3. Secure the pump intake or intake tubing to a stiff pole or weight.
4. Lower the pump intake or intake tubing to the desire sample depth.
5. Pump several tubing volumes through the system prior to collecting the first sample.
6. Remove the sample container cap or lid and fill the sample container from the discharge tubing.
7. If field preservation is required, follow Step 6 through Step 9 in Section 5.3.1 above; otherwise, proceed to Step 8 below;
8. Secure the sample container lid.
9. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.5 Sampling for Biological Analysis

When sampling for biological or bacteriological examination, the procedures described above shall be followed with one exception, unless otherwise specified in the Site-Specific Work and/or FSP. Samples shall be collected in bottles properly sterilized and protected against contamination. As with any sample collection procedure, while the bottle is open, both the bottle and stopper shall be protected against contamination from other sources and the bottle closed at once following sample collection.

6.0 DOCUMENTATION

Sample information, labeling, and custody control shall be performed in accordance with requirements specified in SOP ENV-03-01 and ENV-03-02. Sampling activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP ENV-01-01 or as required by the Site-Specific Work and/or FSP.

7.0 REFERENCES

ASTM International, D3977-97 (2002), Standard Test Methods for Determining Sediment Concentration in Water Samples.

ASTM International, D4581-86 (2005), Guide for Measurement of Morphologic Characteristics of Surface Water Bodies.

ASTM International, D5073-02, Practice for Depth Measurement of Surface Water.

Florida Department of Environmental Protection, February 2004, DEP-SOP-001/01 FS 2100 Surface Water Sampling.

USEPA, November 1994, SOP 2013: Surface Water Sampling, Rev. 0.0, Environmental Response Team.

USEPA, July 2002. Standard Operating Procedures for the Collection of Chemical and Biological Ambient Water Samples. Revision 1.

USEPA. 40 CFR Part 136.3 (e) Table II

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-09-02

STREAMFLOW MEASUREMENT Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes guidelines for the calculation of velocity and stream discharge measurements in rivers and streams. Procedures are given for measurements that can be conducted from water vessels (i.e. boats or barges), bridges (if traversing a representatives section of the river) or by wading with assistance from other field personnel working from the stream bank.

2.0 EQUIPMENT AND MATERIALS

- Flow Meter;
- Top-setting wading rod (measured in tenths of a foot);
- Tape measure or tagline (long enough to traverse the stream bed)
- Stakes to anchor tape to shore;
- Mallet or hammer;
- Field logbook and applicable field data sheets;
- Pen(s) with waterproof, non-erasable ink;
- Waders; and
- Personal protective equipment.

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Work on water requires that marine health and safety procedures are used in addition to standard health and safety procedures. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and

subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 GENERAL PROCEDURES

4.1 Standard Field Procedures

Streamflow measurements shall be conducted only by a trained technician. Field data and observations associated with streamflow measurements shall be documented in accordance with SOP ENV-01-01, if not otherwise specified in this SOP. All activities should be recorded in a field logbook and/or on a streamflow measurement field form.

4.2 Site Selection

The stream transect location is a critical component of streamflow measurement. A site where the stream is most consistent in depth and flow rate across its width is easier to sample and provides more accurate results. Flow sites should be free of eddies, slack water, and excessive turbulence. Avoid areas where islands, ox-bows, piles of debris, aquatic plants or tributaries are present.

4.3 Flow Meter Selection

Several flow meters are available for measuring stream velocity. Some specific meters are the Price Model #1210 (AA); Price Model #1205 (Pygmy) for small, shallow streams; the March-McBirney 201D; and the March-McBirney Flo-Mate 2000. Selection of an appropriate flow meter will depend on the width and depth of the stream being measured, as well as stream features and irregularities. Additional guidance for selection of flow meters may be given in the Site-specific Work Plan.

4.4 Calculation of Stream Discharge

Stream discharge is determined by multiplying the mean stream velocity by the cross sectional area of the flow. The general form of the discharge equation is:

$$Q = A \text{ x } v$$

Where: Q = discharge in cubic feet per second (cfs)
A = cross section area of the channel at the transect in square feet (ft^2)
v = mean water column velocity at the transect in feet per second (ft/s)

To measure discharge (Q), a transect of the stream is divided into subsections and velocity, width and depth measurements are made within each subsection. Discharge of the stream at the transect is calculated by a form of the general equation:

$$Q = \sum_{i=1}^{n} (A_i \, x \, v_i)$$

Where: Q = discharge (cfs)
A_i = cross-sectional area of subsection I (ft^2)
v_i = velocity of subsection (ft/s)

A variation of this equation for mid-section method from Rantz (1982) is presented is Section 7.0 below. Other variations can be found in references listed at the end of this SOP and may be used as specified in the Site-specific Work Plan.

5.0 FIELD MEASUREMENT PROCEDURES

1. Calibrate the flow meter as specified in the manufacturer's instructions.
2. Attach the flow meter to the top set wading rod.
3. Measure the width of the stream at the selected transect location is measured by staking one end of the tape measure or pre-measured and incrementally marked tagline on the right bank. Pull the tape measure across the stream keeping it perpendicular to the flow and stake it on the left bank or use GPS to establish a transect location if sampling from a vessel. Measure the width of the stream from left edge of water (LEW) to right edge of water (REW). LEW is defined as the point where water flow begins on the transect as you face downstream. REW is where water flows ends on the transect.

4. Determine the spacing of transect subsections to be used for velocity measurements. Each subsection should have a width of 5% to 10% of the stream width. For an accurate measurement of discharge, velocity should be measured in 20 to 30 subsections. If inconsistencies in flow rate or streambed topography are present, the number and sizes of subsections can be adjusted to accommodate the differences. Additional guidance on subdividing the transect may be given in the Site-specific Work Plan.
5. Determine the mid-point of each subsection. Use a cumulative measurement. If the stream is 30 feet wide with 20 subsections, the first mid-point is located at 0.75 feet from LEW, the second is located at 2.25 feet from LEW, etc. Draw a rough sketch of the transect with subsections and mid-point measurements in the field logbook and/or on the appropriate field form.
6. Begin the velocity and depth measurements at the first subsection mid-point as measured from the LEW. Measure the total depth of water using the scale on the lower portion of the wading rod or 2-inch diameter graduated aluminum pole. Single indentations on the rod indicate 0.1 foot, double indentations indicate 0.5 foot and triple indentations indicate 1.0 foot. Depending on water depths, velocity measurements will be taken at one or two depths as follows:
    - Depths ≤ 2.5 feet – one measurement is taken at 60% of the total depth when measured from the surface of the water. To set the sensor of the flow meter at 60% of the depth, line up the foot scale on the sliding rod with the tenth scale on the top of the depth gauge rod. For example, if the first subsection is 1.5 feet deep, line up the 1 foot indentation on the sliding rod with the 5 on the tenth scale on the depth gauge rod.
    - Depths > 2.5 feet – two measurements are taken: one at 20% of the total depth and one at 80% of the total depth when measured from the surface of the water. To set the 20% depth point, multiply the depth of the water by two and move the sliding rod so that the foot measurement on it lines up with the tenth of a foot measure on the depth gauge rod. For example, if the first subsection is 2.8 feet deep, twice the depth is 5.6 feet. Line up the number 5 on the sliding rod with the 6 on the depth gauge rod. To set the 80% depth point, divide the depth of the water by two and move the sliding rod to line up with the depth gauge rod based on the results. For example, 2.8 feet divided by 2 equals 1.4 feet. Line up the number 1 on the sliding rod with the 4 on the depth gauge rod. The average of the two velocity measurements are used in the flow calculation.

Take the velocity measurement(s) following the manufacturer's instructions and record them in the field logbook or on the field log form. Proceed to the next subsection of the transect and repeat the procedure across the stream towards the REW.

7. If required, continue to next transect location and repeat the measurement procedures.

6.0 DISCHARGE CALCULATIONS

Calculate the discharge in each transect subsection by multiplying the average velocity (>2.5-foot depth subsection) or single velocity (≤ 2.5-foot depth) by the subsection width and average depth using the equation:

$$Q = (\frac{D_1 + D_2}{2})(\frac{v_1 + v_2}{2})W_1 + ... + (\frac{D_m + D_n}{2})(\frac{v_m + v_n}{2})W_m$$

Where: Q = discharge (cfs)
v = velocity of subsection (ft/s)
W = width of subsection (ft)

Note: The first and last subsections are located at the edges of the stream and have a depth and velocity of zero (D_1, D_n, v_1 and v_n).

7.0 QUALITY ASSURANCE/QUALITY CONTROL

7.1 Equipment Calibration, Operation, and Maintenance

All field equipment shall be calibrated, operated, and maintained in accordance with SOP ENV-02-01 and manufacturer's instructions.

7.2 Calculations

All calculations shall be checked by another person for correctness and use of appropriate equations. Any corrections required will be made by the person originally performing the calculations. These corrections will be checked for correctness and approved for publication.

8.0 REFERENCES AND ADDITIONAL RESOURCES

Carter, R. W. and Davidian, J., 1969, General Procedure for Gaging Streams: Techniques of Water Resources Investigations of the U.S. Geological Survey, Book 3.

California Department of Pesticide Regulation, Environmental Monitoring Branch, 2004, Standard Operating Procedure for Determining Wadable Stream Discharge with Price Current Meters, SOP Number: FSWA009.01.

Rantz, S.E., 1982, *Measurement and Computation of Streamflow: Volumes 1 and 2*, "Measurement of Stage and Discharge", U.S. Geological Survey Water-Supply Paper 2175.

Florida Department of Environmental Protection, Bureau of Watershed Management, Watershed Assessment Section, February 2004, FT 1800 Field Measurement of Water Flow and Velocity. DEP-SOP-001/01.

USEPA, Region 6, January 2003, Standard Operating Procedure for Streamflow Measurement.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

SOP SERIES SAS-10

WITHHELD - NOT RELEVANT TO STUDY ACTIVITIES

SOP SERIES SAS-11

SOIL VAPOR SAMPLING AND MEASUREMENT PROCEDURES

STANDARD OPERATING PROCEDURE NO. SAS-11-01

SUB-SLAB SAMPLE PORT INSTALLATION, SAMPLING, AND ABANDONMENT Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for installation and sampling of sub-slab sample ports. Soil gas sampling is a useful tool to evaluate the potential for vapor intrusion at sites with subsurface chemical impacts and existing buildings. Sub-slab sampling is conducted directly beneath the building's slab to provide measurements of soil gas that may potentially enter a building.

2.0 EQUIPMENT AND MATERIALS

- Rotary hammer drill (or equivalent) with 1-inch and 5/16-inch diameter bits;
- Hand tools, including a hammer, needle-nose pliers, and trowel;
- "T" Swagelok® (compression) or equivalent fitting;
- 3-way and 2-way stopcocks;
- ¼-inch O.D. Teflon™ tubing;
- Tedlar™ bags;
- Plastic helium shroud;
- Broom and dust pan or hand vacuum;
- Beeswax;
- Nitrile gloves;
- Summa™ canisters with flow controllers, particulate filters, vacuum gauges, and shipping container;
- Sample labels;
- Chain of custody forms and seals;
- Field air monitoring instruments, as specified in the Work Plan (e.g. photoionization detector (PID), multi-gas monitors, etc.)
- Location markers (e.g. pin flags, wooden stakes, flagging tape, etc.);

- Asphalt cold patch or cement, as appropriate for site restoration; and
- Field logbook and/or appropriate field forms

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

Variations in chemical-specific characteristics, geologic conditions, and atmospheric influences can affect soil-gas sampling results. For this reason, it is important to understand factors the may influence the reported data when collecting soil-gas data. In all cases, site-specific factors should be carefully evaluated prior to initiation of sampling to obtain representative soil-gas data.

Prior to any soil-gas sampling, soil type must be evaluated for suitability of sampling. Soils with smaller grain sizes have smaller pore spaces and are less permeable, which may reduce the ability for soil gas to be released from the subsurface. For example, clays have the smallest grain size and significantly restrict soil gas migration. Soil moisture also limits the ability for soil gas to be released from the subsurface because moisture trapped in the pore space of sediments can inhibit or block soil-gas flow. Seasonal and geographical variations in soil moisture content can affect air permeabilities. In addition, manmade and naturally occurring preferential pathways (e.g. utility corridors, lenses of coarse-grained materials within fine-grained materials, etc.) may also affect soil-gas migration and shall be considered prior to soil-gas sampling.

Reliability of soil-gas sampling may be improved by using fixed probes and by ensuring that leakage of atmospheric air into the samples is avoided during purging or sampling. To avoid dilution of the sampling region from leakage, the minimum purge volume deemed adequate to flush the sampling system should be removed, and soil-gas samples should be collected from the most permeable zones in the vadose zone when possible. Site-specific information concerning soil lithology, grain size analysis, soil moisture, and soil-gas permeability may be obtained by performing three soil borings in the immediate area of the sampling locations in advance of the soil-gas sampling. In addition, previous site investigation sample results, when available, should be used to determine the placement of the soil-gas sampling locations.

Since oxygen, carbon dioxide, and nitrogen can be sampled using a multi-gas monitor to give real-time results, parallel analysis of oxygen, carbon dioxide, and nitrogen in soil-gas may also be used to help assess the reliability of a given sample result.

5.0 EXECUTION

The active soil-gas sampling approach consists of withdrawing an aliquot of soil gas from the subsurface, followed by the analysis of the withdrawn gas. Active soil-gas systems use mechanical equipment to create a small-diameter hole in the ground and then use a vacuum to "actively" withdraw a soil gas sample through Teflon tubing within the vadose zone. The soil gas sample is collected in a Summa canister and sent to a laboratory for analysis. Samples are analyzed using USEPA's Ambient Air Compendium Method TO-15 (USEPA, 1999) for determining organic compounds in ambient air. The results provided by active soil-gas systems are quantitative and are reported in units of concentration per volume (micrograms per cubic meter [$\mu g/m^3$], or parts per billion volume [ppb_v]).

The following active soil-gas sampling methodologies (port installation and sampling) are based on established methods as outlined in the *USEPA Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (USEPA, 2002) and the ASTM International (ASTM) standard guide D 5314-01 (ASTM, 2001). Additional guidelines were provided from the San Diego County Site Assessment and Mitigation (SAM) Manual, "Overview of Soil Vapor Survey Methods" (San Diego County, 2002 and 2004) and the California Regional Water Quality

Control Board (CRWQCB), Los Angeles Region (LARWQCB) (CRWQCB, 2002 and 2003) and the Department of Toxic Substances Control (DTSC) guidelines (DTSC, 2004).

5.1 PRE-SAMPLING ACTIVITIES

Before starting field activities, attempts should be made to obtain as-built drawings for each building to determine foundation thickness and utility locations. The as-built drawings should be used to finalize probe placement in each of the buildings.

Prior to installing the sub-slab vapor probes, a building survey will be completed. The purpose of the building survey is to document general building structural and use information, including describing the general building uses, presence/absence of wells or sumps, presence/absence of a basement, and documenting potential indoor VOC sources by identifying what chemicals are used or are present in the building. Rooms where probes are proposed should be screened with a PID. If available, Material Safety Data Sheets (MSDSs) for products used in the building will be obtained. The initial building survey will also include identifying the points at which subsurface utilities enter the building. A Building Questionnaire (See Attachments) form should be used for the initial building survey.

5.2 SUB-SLAB SOIL VAPOR PROBE CONSTRUCTION AND INSTALLATION

The sub-slab soil vapor probe installation procedures were derived primarily from the USEPA's *Draft Standard Operating Procedure for Installation of Sub-Slab Vapor Probes and Sampling Using EPA Method TO-15 to Support Vapor Intrusion Investigations* (USEPA, 2002). The sub-slab probes described in the USEPA SOP and in the following procedures are permanent sampling probes that will remain in place after completion of the sampling event. Permanent sampling probes are preferred because they provide higher quality and more consistent data. The individual probes will be removed and the holes sealed upon determining that further sub-slab soil vapor sampling will not be required at a given location.

Use a rotary hammer drill and a clean drill bit to create a shallow (2.5 centimeters (cm) or 1 inch) outer hole that partially penetrates the slab. Areas of visible staining or known previous chemical spills will be avoided. Use a small brush and dust pan or hand vacuum to collect concrete dust and cuttings from the hole. Since the outer hole does not penetrate the floor slab, a dedicated drill bit is not required.

After completing the outer hole, a rotary hammer drill will be used to create a smaller diameter inner hole (0.8 cm or 5/16 inch) through the remainder of the slab and approximately 7 to 8 cm or 3 inches into sub-slab material. The inner hole should be drilled using a dedicated drill bit. Drilling into sub-slab material will create an open cavity which will prevent obstruction of probe inlets during vapor sampling. After completing drilling, the outer hole should be cleaned using a towel moistened with deionized water to increase the potential of obtaining a good seal during cement application.

Probes should be constructed of stainless steel, brass, or Teflon™ tubing and fittings to ensure that construction materials are not a source of VOCs. Metal probe materials should be cleaned with detergent and water prior to installation to remove cutting oils that may have been used in manufacturing. Once the thickness of the slab is known, stainless steel or Teflon™ tubing should be cut to ensure that probes "float" in the slab to avoid obstruction of the probe with sub-slab material. Construct sub-slab vapor probes from small diameter (0.64 cm or 1/4 inch outer diameter x 0.46 cm or 0.18 inch inner diameter) chromatography grade 316 stainless steel or brass tubing and stainless-steel or brass compression to thread fittings (e.g., 0.64 cm or 1/4 inch outer diameter x 0.32 cm or 1/8 inch NPT (National Pipe Tapered) Swagelok® female thread connectors). The probes will be closed using 0.32 cm (1/8 inch) recessed stainless steel or brass socket plugs.

Set sub-slab vapor probes in holes such that the fittings rest at the base of the outer hole and the top of the probes are completed flush with the slab. Each probe will have recessed stainless steel or brass plugs so as not to interfere with day-to-day use of buildings. Mix a quick-drying portland cement that expands upon drying (to ensure a tight seal) with deionized water to form a slurry and inject or push into the annular space between the probe and outside of the outer hole. Allow cement to cure for at least 24 hours prior to sampling.

5.3 SUB-SLAB SAMPLING PROCEDURES

Subsurface vapor will not be sampled if measurable precipitation or irrigation near the sampling location has occurred within the previous five days. The increased soil moisture can reduce soil permeability and cause the soil vapor sample results to be biased low.

5.3.1 Sample Train Assembly

Samples will be collected from the previously installed soil vapor probes using evacuated batch-certified 1 liter (L) or smaller Summa™ canisters equipped with dedicated flow regulators and integrated particulate

filters. A flow regulator/particulate filter and vacuum gauge will be attached to each canister as described in the Summa Canister Instructions provided by the laboratory. Canisters, flow regulators/particulate filters, and vacuum gauges will be supplied by the laboratory.

A helium shroud, consisting of a solid plastic container with a height of less than 6 inches and a volume less than 6L, will be placed around the exposed portion of the soil vapor probe. A dedicated stainless-steel fitting and Teflon™ tubing will be connected to the soil vapor probe while passing through a ¼-inch hole in the side of the helium shroud, no more than three inches above the base of the shroud. All fittings and tubing will be dedicated in order to avoid cross-contamination between probes. A second length of Teflon™ tubing will be inserted into the side of the shroud and connected to a helium cylinder on the outside of the shroud. The Teflon™ tubing attached to the soil vapor probe will be connected to a two-way stopcock. The two-way stopcock will be attached to a three-way stopcock. The other two outlets on the three-way stopcock will be attached to Teflon™ tubing. The tubing from one outlet of the three-way stopcock will be connected to the Summa™ canister assembly, and the tubing from the other outlet will be connected to a 1L Tedlar™ (or equivalent) bag. The Tedlar™ bag will be placed in a lung box. An air pump will be used to evacuate the air inside the lung box and collect a sub-slab soil gas sample in the 1L Tedlar™ bag. A new pair of Nitrile gloves should be worn while connecting the sample assembly for each soil vapor probe. The total length of Teflon™ tubing should not exceed 5 feet.

When collecting duplicate or QA split samples, two separate canister assemblies are connected using a stainless steel “T” fitting, and the “T” fitting is then connected to the three-way stopcock using Teflon™ tubing. The “T” fitting will be provided by the laboratory.

5.3.2 Helium Leak Testing

The purpose of the chemical leak test is to ensure that the sub slab sample port and probe assembly is properly set and not leaking. A leaking sub slab probe assembly could result in a leakage of indoor air into the sub slab sample, potentially biasing the sample. Prior to sampling, a chemical leak test will be performed using helium as a tracer gas. The ambient air inside the shroud will be replaced with helium graded at 99.9 percent purity or higher until the atmosphere consists of a minimum of 20 percent helium. It should be noted that concentrations of 60 percent to 80 percent helium have routinely been observed in the shroud during prior field testing. This will be accomplished by inserting Teflon™ tubing through a ¼ inch hole in the shroud and

attaching the other end to the helium canister. The helium canister will then be opened, and the shroud atmosphere will be continuously monitored by a Dielectric Technologies Model MGD-2002 Multi-Gas Detector (or equivalent) until the percentage of helium inside the shroud reaches a minimum of 20 percent and the readings on the Multi-Gas Detector (or equivalent) stop increasing. The final helium concentration inside the shroud will be recorded on the Field Data Air Sampling Form. The final helium concentration inside the shroud will be multiplied by 10 percent (0.1) to determine the allowable concentration of helium in the Tedlar™ bag sample. Both the final helium concentration inside the shroud and the calculated allowable concentration in the Tedlar™ bag will be recorded on the Field Data Air Sampling Form (See Attachments).

After the target atmosphere is established, the two-way and three-way stopcocks will be opened to the lung box, which contains a 1 L Tedlar™ bag. An air pump attached to the lung box via Teflon™ tubing will be used to evacuate the existing air inside the lung box, which will in turn cause the 1 L Tedlar™ bag to fill. Once filled, the 1 L Tedlar™ bag will be removed from the lung box and the air inside will be measured using the Model MGD-2002 Multi-Gas Detector (or equivalent) for the presence of helium. The concentration of helium measured inside the Tedlar™ bag will be recorded on the Field Data Air Sampling Form. If the concentration of helium in the sample is below the calculated allowable concentration (i.e., less than 10 percent of the concentration inside the helium shroud), proceed with the mechanical leak test and sample collection as described in Sections 5.3.3 and 5.3.4.

Corrective actions to mitigate leaks in the sub-slab soil vapor probe will be performed when the helium concentration in the Tedlar™ bag sample exceeds 10 percent of the starting concentration in the helium shroud. Corrective actions will be performed in the field and will initially involve resealing the probe base with beeswax and repeating the helium leak test. If resealing and retesting fails to produce acceptable leak test results after two attempts, the probe will be abandoned and a new probe will be installed. Samples will not be collected for submittal for laboratory analysis when the helium concentration in the Tedlar™ bag sample exceeds 10 percent of the starting helium concentration in the shroud.

5.3.3 Mechanical Leak Testing

The mechanical leak test will be performed immediately after completing the helium leak test. The mechanical leak test will be completed by closing the two-way stopcock and turning the valve on the three-

way stopcock to close the tubing connected to the lung box assembly. This will close the connection between the two-way stopcock and the lung box assembly and open the connection between the two-way stopcock and the Summa™ canister. Vacuum test the connections between the Summa™ canister and stopcock by opening the canister valve to place a test vacuum on the assembly for 10 minutes. The start time and initial vacuum, as well as the stop time and final vacuum, will be recorded on the Field Data Air Sampling Form and in the field logbook. If gauge vacuum can not be maintained for 10 minutes, work shall be suspended and all fittings in the sample assembly will be checked. Retest the sample assembly. If vacuum still can not be maintained by 10 minutes, sampling activities will be discontinued until leak can be identified and addressed.

If gauge vacuum was maintained for 10 minutes, close the canister valve and immediately proceed with sample collection as described in Section 5.3.4. Since the fitting that connects the tubing from the sub-slab probe to the two-way stopcock cannot be leak tested through either the helium or mechanical leak tests, this fitting will be sealed with Teflon™ tape and beeswax.

5.3.4 Sample Collection

Sample location information and meteorological conditions (temperature, barometric pressure, wind speed/direction, and relative humidity) shall be recorded on a Field Data Air Sampling Form. Meteorological data will be obtained online from the nearest National Weather Service measuring station. Digital photos will be taken of each sample location and sample assembly.

Open the two-way stopcock connecting the Summa™ canister assembly to the soil vapor probe. Open the canister valve to begin sample collection. The time and initial vacuum when sample collection starts shall be recorded on the Field Data Air Sampling Form. The laboratory-provided flow regulators will be calibrated for a 5- to 10-minute sample duration, which correlates to a flow rate of 100 to 200 mL/min. Close the sample canister valve when the vacuum gauge indicates approximately 3-5 inches Hg (mercury) of vacuum remain in the canister. Sample collection should take approximately 5 minutes for a 1L Summa™ canister connected to a 200 mL/min flow regulator. The time sample collection was stopped and final vacuum shall be recorded on the Field Data Air Sampling Form. Remove the flow regulator/particulate filter and vacuum gauge assembly and replace the laboratory-supplied brass plug on the canister. Disconnect the sample tubing assembly and replace the plug on the soil vapor probe.

Label the sample canister and record on the COC the sample name, date and time the sample was collected, the canister and flow controller serial numbers, and the final vacuum gauge reading. Samples shall not be chilled or subjected to extreme temperature or pressure fluctuations. Samples will be shipped to the laboratory for analysis of VOCs by USEPA Method TO-15.

5.3.5 Quality Control

Trip blanks, field duplicates, and QA samples will be collected during soil vapor sampling activities. Field duplicates and QA split samples will be collected at the rate of one duplicate/QA sample per 10 soil vapor samples (i.e., 10 percent). Normally, field duplicates and QA samples are collected from the same location; however, the "T" connectors used to collect duplicate samples can not be used to collect three simultaneous samples. Therefore, the duplicate and QA samples will be collected from separate locations.

A trip blank, consisting of an unopened evacuated canister, will be sent with each shipment of sub-slab vapor samples. Trip blanks can consist of either unopened fully evacuated canisters or canisters that have been fully charged with zero grade air by the laboratory. Since a fully charged canister has no vacuum with which to pull contaminants into the canister, a fully evacuated canister has a better likelihood of capturing potential transit-related contamination. The trip blank will be provided by the laboratory.

6.0 EQUIPMENT DECONTAMINATION PROCEDURES

All decontamination will be performed according to SAS-04-04.

7.0 INVESTIGATION-DERIVED WASTE (IDW)

The sub-slab vapor probe installation and sampling will generate small amounts of solid IDW including concrete dust, gloves, drill bits, and tubing. This material will be bagged and disposed of as a municipal waste in accordance with applicable regulations. No liquid IDW will be generated. Further discussion of IDW can be found in Section 9 of the *Multi-Site Field Sampling Plan, Former Manufactured Gas Plant Sites, Revision 3", February 20, 2008.*

8.0 REFERENCES

ASTM International, 2001, ASTM Standard D 5314-92 (2001) Standard Guide for Soil Gas Monitoring in the Vadose Zone.

California Regional Water Quality Control Board, Los Angeles Region, 2002, General Laboratory Testing Requirements for Petroleum Hydrocarbon Impacted Sites.

California Regional Water Quality Control Board, Los Angeles Region, 1997, Interim Guidance for Active Soil Gas Investigation, Advisory issued January 28, 2003.

Department of Toxic Substance Control-California Environmental Protection Agency, 2004, Interim Final Guidance to the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air, Revised February 7, 2005.

San Diego County, Site Assessment and Mitigation (SAM) Manual, "Overview of Soil Vapor Survey Methods" Final Draft 8/20/2002.

San Diego County, 2004, Site Assessment and Mitigation (SAM) Manual, "Overview of Soil Vapor Survey Methods".

United States Environmental Protection Agency (USEPA), 2002. *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance).* Office of Solid Waste and Emergency Response. November 29.

USEPA, 1999, Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected In Specially-Prepared Canisters and Analyzed By Gas Chromatography/Mass Spectrometry GC/MS) in *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, 2nd Ed., EPA Publication 625/R-96/010b.

STANDARD OPERATING PROCEDURE NO. SAS-11-05

FIELD SCREENING FOR FIXED GASES AND SOIL VAPOR CONCENTRATIONS Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for conducting the field screening soil vapor samples collected using Tedlar™ bag media. The field screening consists of instrument calibration, real-time determination of fixed gases (oxygen and carbon dioxide) levels, percent of lower explosive limit (% LEL), and soil vapor concentrations (as determined using a photoionization detector [PID] and flame ionization detector [FID]), and documentation of field screening results.

2.0 EQUIPMENT AND MATERIALS

- LandTec GA-90 Landfill Gas Analyzer or equivalent
- RAE Systems ppbRAE continuous monitoring PID or equivalent
- Thermo Electron TVA 1000B PID and FID or equivalent
- Calibration Gases:
  - Zero Gas – Hydrocarbon (HC) Free Air
  - Carbon dioxide (CO_2) at 35% by volume
  - Oxygen (O_2) at 4% by volume
  - Isobutylene at 0.5% by volume
  - Methane (CH_4) at 3.25% by volume
  - Isobutylene in air at concentrations of 10, 50 and 1,000 ppmv
  - Methane (CH_4) in air at concentrations of 50, 500, and 5,000 ppmv
- Regulators for gas cylinders
- 1-liter Tedlar™ bag sample media
- ¼-inch outer diameter (O.D.) Teflon™ or Tygon™ tubing cut to length
- Thermo Electron Dilutor Orifice 10:1 (a.k.a. 10-to-1 dilution probe)
- Thermo Electron Dilutor Orifice 25:1 (a.k.a. 25-to-1 dilution probe)

- Thermo Electron Dilutor Orifice 50:1 (a.k.a. 50-to-1 dilution probe)
- Metering valves
- Field Screening Calibration Forms
- Field Screening Spreadsheet and/or Forms
- Miscellaneous tools

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

- Calibration gas cylinders shall be stored in accordance with OSHA and site-specific regulations/guidelines.
- Field screening instruments shall be stored between uses and maintained in accordance with manufacturer guidelines.
- Field screening shall be performed at a fixed location, when practical, with adequate ventilation.
- A ppbRAE or equivalent may be used as an optional screening tool to confirm low level volatile organic compound (VOC) concentrations.

5.0 INSTRUMENT SPECIFICATIONS

Instrument specifications are intended as general guidelines only. Instruments may be substituted based on project/task specific needs.

5.1 LandTec GA-90 or Equivalent

A LandTec GA-90 or equivalent shall be used to measure O_2 and CO_2 levels as percent by volume (%) in soil vapor samples. If required by project/task specific requirements, this instrument may be used to measure the % LEL in soil vapor samples.

5.2 ppbRAE or Equivalent

A ppbRAE or equivalent may be used as an optional screening tool to measure and confirm low level VOCs in soil vapor samples. The ppbRAE or equivalent, when used, shall measure VOCs as parts per billion by volume (ppbv) and/or parts per million by volume (ppmv).

5.3 TVA 1000B or Equivalent

A Toxic Vapor Analyzer (TVA 1000B) or equivalent shall be used to measure low to high level VOCs as ppmv in soil vapor samples. The TVA 1000B or equivalent shall also be used to measure low to high level total hydrocarbons (THC) as ppmv or percent by volume ($\%_V$) in soil vapor samples.

6.0 INSTRUMENT CALIBRATION

In order to ensure the collection of valid levels of fixed gases, O_2 and CO_2, and soil vapor concentrations as total hydrocarbons (THC), proper calibration of the instruments is important. Instruments shall be calibrated prior to field screening in accordance with the manufacturers recommended procedures. Calibration gases shall be introduced directly at a rate of 0.5 liters per minute to the LandTec GA-90 or equivalent since the instrument pump is not required for calibration. Calibration standard gases shall be introduced to the ppbRAE, TVA 1000B PID, and TVA 1000B FID using Tedlar™ bag media which will allow the instrument pump to draw in the calibration gas at the appropriate flow. Following screening activities each day, a post-screening calibration check shall be performed. If the screening instruments are to be used continuously throughout the workday, mid-screening calibration checks shall also be performed. One-point bump

calibration checks shall also be performed on the TVA 1000B or equivalent and associated dilution probe(s) at a frequency of one per two-hours of field screening. Calibration gases with concentrations within the linear range of the instrument shall be used for the pre-screening calibration and post-screening calibration check in addition to the mid-screening and one-point bump calibration checks, when required.

6.1 Pre-Screening Calibration

6.1.1 LandTec GA-90 or equivalent

Prior to the start of field screening, the LandTec GA-90 or equivalent shall be calibrated in accordance with the manufacturers recommended procedures using 4.0% $_V$ O_2 and 35% $_V$ CO_2 standard gases (see Attachment A). The pre-screening calibration shall be documented on the appropriate instrument calibration form (see Attachment A).

6.1.2 ppbRAE or equivalent

Prior to the start of optional, confirmatory low level PID field screening, the ppbRAE or equivalent shall be calibrated in accordance with the manufacturers recommended procedures using hydrocarbon free air (0 ppmv THC by volume) and 10 ppmv isobutylene standard gas (see Attachment A). The pre-screening calibration shall be documented on the appropriate instrument calibration form (see Attachment A).

6.1.3 TVA 1000B or equivalent

Prior to the start of field screening, the PID portion of the TVA 1000B or equivalent shall be calibrated in accordance with the manufacturers recommended procedures using hydrocarbon free air (0% $_V$ THC) and 50 and 1,000 ppmv isobutylene standard gases. The FID portion of the TVA 1000 or equivalent shall be calibrated in accordance with the manufacturers recommended procedures using hydrocarbon free air (0% $_V$ THC) and 50, 500, and 5,000 ppmv methane standard gases (see Attachment A). The pre-screening calibration shall be documented on the appropriate instrument calibration form (see Attachment A).

6.1.4 Dilution Probes

Following the calibration of the TVA 1000B PID and FID, each dilution probe shall be calibrated by adjusting the associated metering valve until the concentration displayed on the instrument is within (+/-) 15% of the target concentration of the designated calibration gases. The following table summarizes the type and concentration of calibration gas, target displayed concentration, and acceptable range for each dilution probe and instrument. The pre-screening calibration shall be documented on the appropriate instrument calibration form (see Attachment A).

Instrument	Dilution Probe	Calibration Gas		Concentration Displayed on Instrument	
		Type	Concentration	Target (ppmv)	Acceptable Range (ppmv)
TVA 1000B PID	10-to-1	Isobutylene	0.5 $\%_V$	500	425 – 575
TVA 1000B FID	10-to-1	Methane	3.25$\%_V$	3,250	2,762 – 3,738
	25-to-1	Methane	3.25$\%_V$	1,300	1,105 – 1,495
	50-to-1	Methane	3.25$\%_V$	650	552 – 748

6.2 Mid- and Post-Screening Calibration Checks

Properly calibrated instruments may drift during the field screening period. In order to ensure the collection of valid data, calibration accuracy checks will be conducted at the conclusion of the field screening each day. If the screening instruments are to be used throughout the workday, mid-screening calibration checks shall also be performed.

6.2.1 LandTec GA-90 or equivalent

The calibration of the LandTec GA-90 or equivalent shall be checked using 4.0 $\%_V$ O_2 and 35% $_V$ CO_2 standard gases. If the observed concentration/level is within (+/-) 15% of the standard gases, the calibration shall be considered adequate. If the observed concentration/level is outside that range, the LandTec GA-90 or equivalent shall be recalibrated. Data obtained since the previous calibration check shall be flagged as estimated values. The following table summarizes the type and concentration of calibration gas, target displayed concentration, and acceptable range for each fixed gas. The calibration checks shall be documented on the appropriate instrument calibration form (see Attachment A).

Fixed Gas	Calibration Gas		Concentration Displayed on Instrument	
	Type	Concentration	Target (%)	Acceptable Range (%)
Oxygen	O_2 Standard	4.0% $_V$	4.0	3.4 – 4.6
Carbon Dioxide	CO_2 Standard	35.0%$_V$	35.0	29.75 – 40.25

6.2.2 ppbRAE or equivalent

The calibration of the ppbRAE or equivalent shall be checked using hydrocarbon free air (0 ppmv THC by volume) and 10 ppmv isobutylene standard gases, if the observed concentration/level is within (+/-) 15% of the calibration gases, the calibration shall be considered adequate. If the observed concentration/level is outside that range, the ppbRAE or equivalent shall be recalibrated. Data obtained since the previous calibration check shall be flagged as estimated values. The following table summarizes the type and concentration of calibration gas, target displayed concentration, and acceptable range for the ppbRAE. The calibration checks shall be documented on the appropriate instrument calibration form (see Attachment A).

Instrument	Calibration Gas		Concentration Displayed on Instrument	
	Type	Concentration	Target (ppmv)	Acceptable Range (ppmv)
ppbRAE	HC Free Air	0.0 ppmv	0.0	0.08 – 0.15
	Isobutylene	10.0 ppmv	10.0	8.5 – 11.5

6.2.3 TVA 1000B or equivalent

Given the wide range of hydrocarbons anticipated, the linearity of the PID response shall be checked using hydrocarbon free air (0% $_V$ THC) and 50 and 1,000 ppmv isobutylene standard gases. The FID response shall be checked using 50, 500, and 5000 ppmv methane standard gases. If the observed concentration/level is within (+/-) 15% of the standard gases, the calibration shall be considered adequate. If the observed concentration/level is outside that range, the TVA 1000B or equivalent shall be recalibrated. Data obtained since the previous calibration check shall be flagged as estimated values. The following table summarizes the type and concentration of calibration gases, target displayed concentration, and acceptable range for each

instrument. The calibration checks shall be documented on the appropriate instrument calibration form (see Attachment A).

Instrument	Dilution Probe	Calibration Gas		Concentration Displayed on Instrument	
		Type	Concentration	Target (ppmv)	Acceptable Range (ppmv)
TVA 1000B PID	None	HC Free Air	0.0 ppmv	0.0	0.08 – 0.15
		Isobutylene	50.0 ppmv	50.0	42.5 – 57.5
			1,000 ppmv	1,000	850 – 1150
TVA 1000B FID	None	HC Free Air	0.0 ppmv	0.0	0.08 – 0.15
		Methane	50.0 ppmv	50.0	42.5 – 57.5
			500 ppmv	500	425 – 575
			5,000 ppmv	5,000	4250 – 5750

6.2.4 Dilution Probes

Following the calibration check of the TVA 1000B PID and FID, each dilution probe and associated metering valve shall be shall be verified using designated type and concentration of standard gas. The dilution probe calibration is considered adequate if the concentration displayed on the instrument is within (+/-) 15% of the target concentration of the designated calibration gas. The following table summarizes the type and concentration of calibration gas, target displayed concentration, and acceptable range for each dilution probe and instrument. The calibration checks shall be documented on the appropriate instrument calibration form (see Attachment A)

Instrument	Dilution Probe	Calibration Gas		Concentration Displayed on Instrument	
		Type	Concentration	Target (ppmv)	Acceptable Range (ppmv)
TVA 1000B PID	10-to-1	Isobutylene	0.5% $_V$	500	425 – 575
TVA 1000B FID	10-to-1	Methane	3.25% $_V$	3,250	2,762.5 – 3,737.5
	25-to-1	Methane	3.25% $_V$	1,300	1,105 – 1,495
	50-to-1	Methane	3.25% $_V$	650	552.5 – 747.5

6.3 Periodic Bump Calibration Checks

Due to the negligible (< 5%) instrument drift throughout a day, the LandTec GA-90 and ppbRAE or equivalent(s) will not undergo periodic bump calibration checks. Given the wide range of hydrocarbons anticipated, one-point, calibration bump checks shall be performed on the TVA 1000B PID and FID, dilution probes, and associated metering valves or equivalents. The period bump calibration check shall be performed at a frequency of one per two-hours of field screening. The calibration is considered adequate if the concentration displayed on the instrument is within (+/-) 15% of the target concentration of the designated calibration gas. If the observed concentration is outside this range, the instrument and/or dilution probe and metering valve shall be recalibrated as appropriate. Data obtained since the previous bump calibration check shall be flagged as estimated values. The following table summarizes the type and concentration of calibration gas, target displayed concentration, and acceptable range for each dilution probe and instrument. The calibration checks shall be documented on the appropriate instrument calibration form (see Attachment A).

Instrument	Dilution Probe	Calibration Gas		Concentration Displayed on Instrument	
		Type	Concentration	Target (ppmv)	Acceptable Range (ppmv)
TVA 1000B PID	None	Isobutylene	50.0 ppmv	50.0	42.5 – 57.5
	10-to-1	Isobutylene	0.5% $_V$	500	425 – 575
TVA 1000B FID	None	Methane	5,000 ppmv	5,000	4250 – 5750
	10-to-1	Methane	3.25%$_V$	3,250	2,762 – 3,738
	25-to-1	Methane	3.25%$_V$	1,300	1,105 – 1,495
	50-to-1	Methane	3.25%$_V$	650	552 – 748

7.0 SAMPLE SCREENING

Soil vapor samples collected in Tedlar™ bags shall be screened at a fixed location, whenever practical. Since samples may have 1) concentrations above the measurement range of the instrument or 2) insufficient oxygen content to analyze reliably, the order of the screening is important to the identification of these situations. The screening order is also dictated by the sample flow rates, which vary by instrument, and the sample volume.

7.1 Screening Procedures

Prior to field screening, the well/sample ID, sample date, and sample time shall be recorded on the appropriate field form and/or spreadsheet (see Attachment C). Once the screening data and time have also been recorded on the appropriate field form and/or spreadsheet (see Attachment C), the field screening shall commence. The soil vapor samples shall be analyzed in the following order:

- Fixed gases (O_2 and CO_2)
- Percent of lower explosive limit (% LEL) - If required by the project or task
- Soil vapor concentrations (VOCs) as determined using a PID
- Soil vapor concentrations (THC) as determined using a FID

The field screening shall adhere to the procedure outlined in the Field Screening Procedure Flow Chart provided in Attachment B. Following screening the Tedlar™ bag sample media shall be discarded.

7.2 Reporting

Field screening results as observed on the instruments, fixed gases levels (O_2 & CO_2), percent lower explosive limit, and soil vapor concentrations, as determined using a PID and FID, shall be recorded in the appropriate spreadsheet or on the appropriate field form (see Attachment C). The use of a dilution probe shall also be documented in the appropriate spreadsheet or on the appropriate field form (see Attachment C). *Please note: Concentrations as determined using a PID and FID shall be corrected for the use of dilution probe(s).* If the concentration of the vapor sample exceeds the operating range of the instrument, with or without the use of a dilution probe, it shall be marked as "estimated". If a flame-out of the FID occurs, "FO" shall be recorded as the default value for the affected sample. If the flame-out was not the result of 1) insufficient sample flow, 2) FID capsule contamination, or 3) insufficient oxygen in the sample (<14% when adjusted to account for the use or absence of a dilution probe), the upper dynamic range of the instrument, which has been adjusted for the use of or absence of a dilution probe, shall be used as the corrected FID reading. In this case, the reading shall be flagged as estimated. These situations shall be documented in the appropriate spreadsheet or on the appropriate field form.

8.0 SAMPLE HOLD TIMES

Soil vapor samples collected using Tedlar™ bag media shall be field screened at a fixed location, if practical, within thirty-six (36) hours of sample collection.

9.0 REFERENCES AND ADDITIONAL RESOURCES

Field Environmental Instruments, LANDTEC GA-90 Gas Analyzer Specifications and Features.

LANDTEC, GA-90 Landfill Gas Analyzer Operation Manual, Version MK2C1.12.

RAE Systems, 1999, Portable Continuous ppb VOC Detector Monitor Specifications and Features.

RAE Systems, 1999, Using the MiniRAE 2000 & ppbRAE plus.

Thermo Electron Corporation, 2003, Product Overview TVA-1000B Toxic Vapor Analyzer.

Thermo Electron Corporation, 2003, TVA-1000B Toxic Vapor Analyzer Instruction Manual P/N BK3500, December.

USEPA, 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

ATTACHMENT A
INSTRUMENT CALIBRATION FORMS

ATTACHMENT A-1
LANDTEC GA-90 LANDFILL GAS ANALYZER OR EQUIVALENT

FIELD SCREENING INSTRUMENT CALIBRATION FORM
LandTec GA-90 or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION | **INSTRUMENT INFORMATION**

Date: _____ **Make:** _____
Screener: _____ **Model:** _____
Assistant: _____ **Serial #:** _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response	Response within Tolerances (circle one)	Comments
		Type	Conc.			
	Pre-Screening Calibration[R]	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Mid-Screening Calibration Check*	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Post-Screening Calibration Check[R]	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Mid-Screening Recalibration*	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Mid-Screening Recalibration*	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	

Notes: 1. [R] = Required 2. * = If necessary 3. % = percent by volume

ATTACHMENT A-2
ppbRAE or EQUIVALENT

FIELD SCREENING INSTRUMENT CALIBRATION FORM
ppbRAE or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION | **INSTRUMENT INFORMATION**

Date: _____ **Make:** _____
Screener: _____ **Model:** _____
Assistant: _____ **Serial #:** _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard Type	Calibration Standard Conc.	Instrument Response	Response within Tolerances (circle one)	Comments
	Pre-Screening Calibration[R]	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Calibration Check*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Post-Screening Calibration Check[R]	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	

Notes: 1. [R] = Required 2. * = If necessary 3. ppmv = parts per million by volume

ATTACHMENT A-3
TVA-1000B TOXIC VAPOR ANALYZER OR EQUIVALENT

FIELD SCREENING INSTRUMENT CALIBRATION FORM
TVA 1000 (FID) or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION

Date: _____
Screener: _____
Assistant: _____

INSTRUMENT INFORMATION

Make: _____
Model: _____
Serial #: _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response				Response(s) within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe	w/ 25-to-1 Dilution Probe	w/ 50-to-1 Dilution Probe		
	Pre-Screening Calibration[R]	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Mid-Screening Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	

CALIBRATION AND CALIBRATION CHECK INFORMATION (Continued)									
Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response				Response(s) within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe	w/ 25-to-1 Dilution Probe	w/ 50-to-1 Dilution Probe		
	Post-Screening Calibration Check[R]	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	

Notes: 1. [R] = Required 2. * = If necessary 3. ppmv = parts per million by volume 4. N/A = Not Applicable

FIELD SCREENING INSTRUMENT CALIBRATION FORM
TVA 1000 (PID) or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION

Date: _____
Screener: _____
Assistant: _____

INSTRUMENT INFORMATION

Make: _____
Model: _____
Serial #: _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response		Response within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe		
	Pre-Screening Calibration[R]	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Mid-Screening Calibration Check*	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Post-Screening Calibration Check[R]	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	

CALIBRATION AND CALIBRATION CHECK INFORMATION (Continued)							
Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response		Response within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe		
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	

Notes: 1. R = Required 2. * = If necessary 3. ppmv = parts per million by volume

ATTACHMENT B
FIELD SCREENING PROCEDURE FLOW CHART

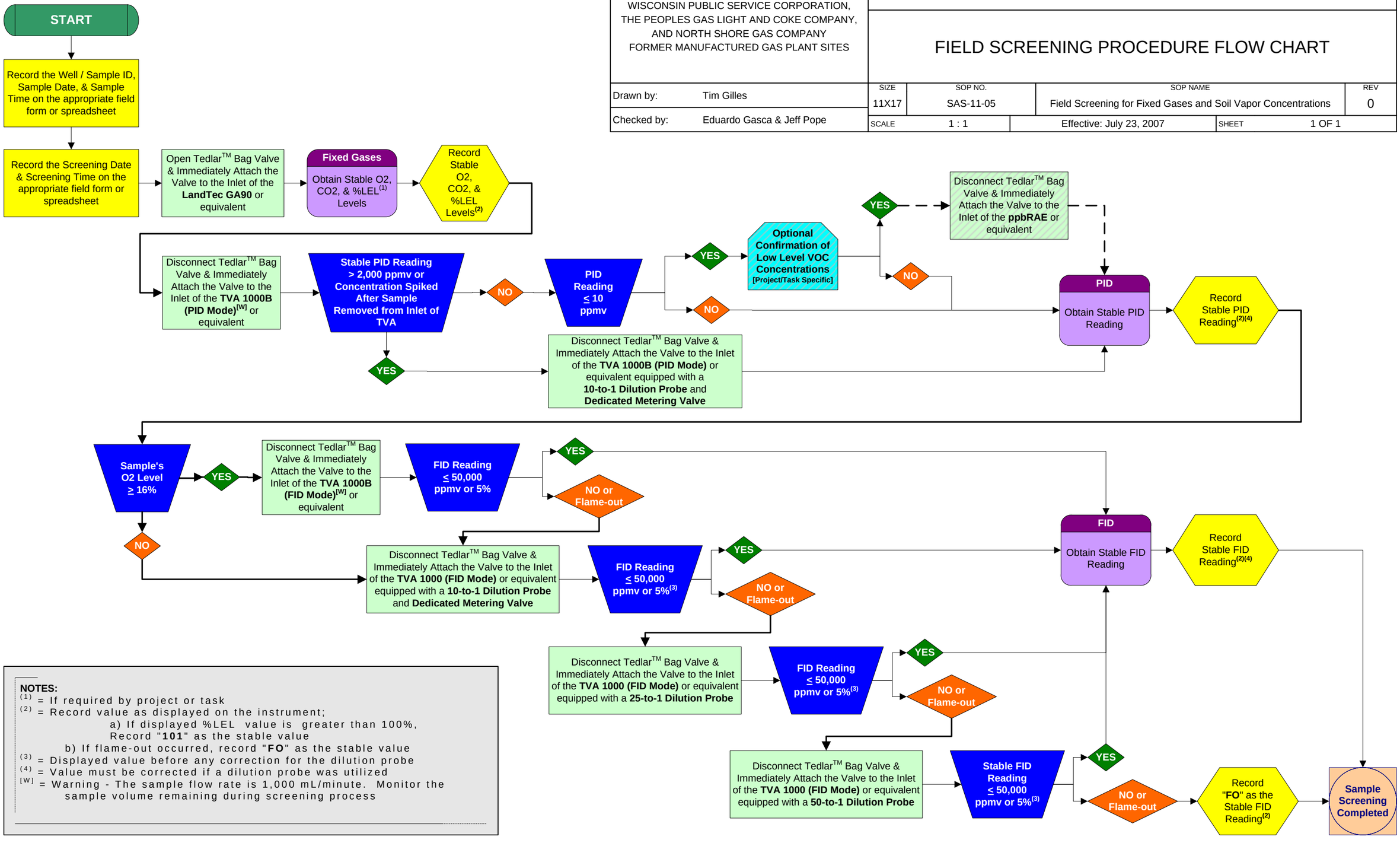
WISCONSIN PUBLIC SERVICE CORPORATION,
THE PEOPLES GAS LIGHT AND COKE COMPANY,
AND NORTH SHORE GAS COMPANY
FORMER MANUFACTURED GAS PLANT SITES

SOP SAS-11-05 ATTACHMENT B

FIELD SCREENING PROCEDURE FLOW CHART

Drawn by:	Tim Gilles
Checked by:	Eduardo Gasca & Jeff Pope

SIZE	SOP NO.	SOP NAME	REV
11X17	SAS-11-05	Field Screening for Fixed Gases and Soil Vapor Concentrations	0
SCALE 1 : 1	Effective: July 23, 2007	SHEET 1 OF 1	



NOTES:

(1) = If required by project or task

(2) = Record value as displayed on the instrument;
a) If displayed %LEL value is greater than 100%, Record "**101**" as the stable value
b) If flame-out occurred, record "**FO**" as the stable value

(3) = Displayed value before any correction for the dilution probe

(4) = Value must be corrected if a dilution probe was utilized

[W] = Warning - The sample flow rate is 1,000 mL/minute. Monitor the sample volume remaining during screening process

ATTACHMENT C
FIELD SCREENING RESULTS SPREADSHEET/FORM

FIXED GASES AND SOIL VAPOR CONCENTRATION FIELD SCREENING DATA

PROJECT INFORMATION		GENERAL INSTRUMENT INFORMATION		SCREENER INFORMATION	
Project Name:		Fixed Gases:		Screener's Name:	
Project Number:		PID (Low Level Confirmation):		Screener's Title:	
Task Name:		PID (Low-High Level):		Assistant's Name:	
Task/Project Manager:		FID (Low-High Level):		Assistant's Title:	

FIELD SCREENING RESULTS

WELL ID or SAMPLE ID	SAMPLE DATE	SAMPLE TIME (24-Hour)	SCREENING DATE	SCREENING TIME (24-Hour)	Observed Field Screening Values(1), Units, and Dilution Values(2)									Corrected Value(3)		COMMENTS
					O_2 (%)	CO_2 (%)	% LEL(4) (%)	PID	PID UNITS (circle one)	PID Dilution Value(2) (circle one)	FID	FID UNITS (circle one)	FID Dilution Value(2) (circle one)	PID (ppmv)	FID (ppmv)	
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			

FIELD SCREENING RESULTS																
WELL ID or SAMPLE ID	SAMPLE DATE	SAMPLE TIME (24-Hour)	SCREENING DATE	SCREENING TIME (24-Hour)	Observed Field Screening Values[1], Units, and Dilution Values[2]									Corrected Value[3]		COMMENTS
					O_2 (%)	CO_2 (%)	% LEL[4] (%)	PID	PID UNITS (circle one)	PID Dilution Value[2] (circle one)	FID	FID UNITS (circle one)	FID Dilution Value[2] (circle one)	PID (ppmv)	FID (ppmv)	
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			

FIELD SCREENING RESULTS																	
WELL ID or SAMPLE ID	**SAMPLE DATE**	**SAMPLE TIME (24-Hour)**	**SCREENING DATE**	**SCREENING TIME (24-Hour)**	**Observed Field Screening Values[1], Units, and Dilution Values[2]**									**Corrected Value[3]**		**COMMENTS**
					O_2 (%)	**CO_2 (%)**	**% LEL[4] (%)**	**PID**	**PID UNITS (circle one)**	**PID Dilution Value[2] (circle one)**	**FID**	**FID UNITS (circle one)**	**FID Dilution Value[2] (circle one)**	**PID (ppmv)**	**FID (ppmv)**	
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			

Notes: [1] = As observed on the instrument's display; If flame-out occurs, record "FO" as the default value.

[2] = Dilutions Values (Dilution Probe Specific): No Dilution Probe Used - Circle "1"; 10-to-1 Dilution Probe Used - Circle "10"; 25-to-1 Dilution Probe Used - Circle "25"; 50-to-1 Dilution Probe Used - Circle "50"

[3] = Calculated based on the units and dilution value or, in the case of a flame-out when sufficient oxygen is present, the upper dynamic range of the instrument multiplied by the dilution value.

[4] = If required by project or task

E = Estimated Value: Corrected value exceeds the upper dynamic range of the instrument or flame-out due to concentrations above the instruments range occurred.

ppbv = Parts per billion volume

ppmv = Parts per million volume

% = Percent by volume

N/A = Not Applicable

FO = Instrument Flame Out (FID Only)

STANDARD OPERATING PROCEDURE NO. SAS-11-06

SOIL GAS SAMPLING Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides information on soil-gas sampling using an active sampling approach to assess the vapor intrusion pathway. Soil gas will be sampled using dedicated gas vapor tips and the associated installation kit or direct-push rig. Soil gas samples will be collected from the unsaturated zone to provide measurements of soil gas that may potentially enter a building.

2.0 EQUIPMENT AND MATERIALS

- Rotary hammer drill (or equivalent) with a 1 3/8-inch diameter bit;
- Retractable gas vapor tip (GVP);
- Expendable GVP replacements;
- Hand Tools, including a hammer, needle-nose pliers, and trowel;
- Tubing receptacle;
- Teflon compression fittings to connect sampling points at “T” connection;
- “T” Swagelok (compression) or equivalent fitting;
- Stainless steel tubing;
- Gas sampling pump capable of extracting 200 milliliters per minute (mL/min);
- 4-way Teflon micro-valve;
- 1/4-inch O.D. Teflon tubing;
- VOC-free caulk;
- Nitrile gloves;
- Summa canisters with flow controllers, vacuum gauge, and shipping container;
- Sample labels;
- Chain of custody forms and seals;

- Field air monitoring instruments, as specified in the Work Plan (e.g. photo ionization detector, multi-gas monitors, etc.);
- Location markers (e.g. pin flags, wooden stakes, flagging tape, etc.);
- Granular bentonite;
- Asphalt cold patch or cement, as appropriate for site restoration;
- Decontamination materials;
- DOT-specified 55-gallon drum; and
- Field logbook and/or appropriate field form(s);

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

Variations in chemical-specific characteristics, geologic conditions, and atmospheric influences can affect soil-gas sampling results. For this reason, it is important to understand factors the may influence the reported data when collecting soil-gas data. In all cases, site-specific factors should be carefully evaluated prior to initiation of sampling to obtain representative soil-gas data.

Prior to any soil-gas sampling, soil type must be evaluated for suitability of sampling. Soils with smaller grain sizes have smaller pore spaces and are less permeable, which may reduce the ability for soil gas to be released from the subsurface. For example, clays have the smallest grain size and significantly restrict soil gas migration. Soil moisture also limits the ability for soil gas to be released from the subsurface because moisture trapped in the pore space of sediments can inhibit or block soil-gas flow. Seasonal and geographical

variations in soil moisture content can affect air permeabilities. In addition, manmade and naturally occurring preferential pathways (e.g. utility corridors, lenses of coarse-grained materials within fine-grained materials, etc.) may also affect soil-gas migration and shall be considered prior to soil-gas sampling.

Reliability of soil-gas sampling may be improved by using fixed probes and by ensuring that leakage of atmospheric air into the samples is avoided during purging or sampling. To avoid dilution of the sampling region from leakage, the minimum purge volume deemed adequate to flush the sampling system should be removed, and soil-gas samples should be collected from the most permeable zones in the vadose zone when possible. Site-specific information concerning soil lithology, grain size analysis, soil moisture, and soil-gas permeability may be obtained by performing three soil borings in the immediate area of the sampling locations in advance of the soil-gas sampling. In addition, previous site investigation sample results, when available, should be used to determine the placement of the soil-gas sampling locations.

Since oxygen, carbon dioxide, and nitrogen can be sampled using a multi-gas monitor to give real-time results, parallel analysis of oxygen, carbon dioxide, and nitrogen in soil-gas may also be used to help assess the reliability of a given sample result.

5.0 SOIL VAPOR PROBE INSTALLATION

Prior to installation at each soil vapor probe location, the area will be inspected for clearance of existing utility lines and other obstructions near the sample location. The soil vapor probes will then be installed into the ground surface using a hammer drill connected to drive rods or a direct-push rig. Installation using a hammer drill should be used when depths of less than 10 feet are desired. For depths greater than 10 feet, a direct-push rig will more efficiently drive the probe rods. The soil vapor probes consist of a stainless steel drive tip which is connected to a screen with a length between 2 to 6 inches and diameter of at least 1/8-inch but no larger than 1/2-inch. At the top of the screen, a stainless steel hose barb allows for a connection to Teflon™ or stainless steel tubing for purging and sample collection. Soil gas probes installed at depths greater than 10 feet should be constructed with stainless steel tubing for durability and stability. After the probe is driven to the desired depth, the rods will be removed and a filter pack containing sand will be set to within 2 inches above and below the vapor probe. Above the sand filter pack, granular bentonite will be

placed and hydrated in two-foot lifts to ground surface. This bentonite will provide an airtight seal between the soil gas probe and the ambient air. Probes should not be installed shallower than two feet below ground surface (bgs). Each probe will be allowed to set for at least 24 hours before sampling takes place.

6.0 SOIL VAPOR SAMPLING PROCEDURES

Subsurface soil vapor will not be sampled if measurable precipitation or irrigation near the sampling location has occurred within the previous five days. The increased soil moisture can decrease soil permeability and cause the soil vapor sample results to be biased low.

6.1 SAMPLE TRAIN ASSEMBLY

Samples will be collected using evacuated batch-certified 1 liter (L) or smaller Summa™ canisters equipped with dedicated flow regulators and integrated particulate filters. A flow regulator/particulate filter and vacuum gauge will be attached to each canister as described in the *Summa Canister Instructions* provided by the laboratory. Canisters, flow regulators/particulate filters, and vacuum gauges will be supplied by the laboratory.

When probe installation is complete, Teflon™ tubing will extend from the probe to the ground surface. The Teflon™ tubing will be connected to a two-way and three-way stopcock assembly. One output of the stopcock assembly will be connected to the Summa™ canister using a Swagelok™ fitting. The other output of the stopcock assembly will be connected to a lung box containing a Tedlar™ bag. Use of dedicated tubing will avoid cross-contamination between probes. A new pair of Nitrile gloves should be worn while connecting the sample assembly for each soil vapor probe.

When collecting duplicate or QA split samples, two separate canister assemblies are connected using a stainless steel “T” fitting, and the “T” fitting is then connected to the Teflon™ tubing assembly described in the previous paragraph. The “T” fitting will be provided by the laboratory.

6.2 PURGING SOIL VAPOR PROBES

Allow the probe to equilibrate for a minimum of 24 hours from the time of installation before initiating purge procedures. Teflon™ tubing coming from the soil vapor probe will be connected to a lung box containing a Tedlar™ bag. The vapor probe will be purged during the chemical leak test by removing a volume of air

equal to three times the volume of the sample probe and tubing. Purging will be conducted using a flow rate of 100 to 200 milliliters per minute (mL/min). Given the small volume of the sample probes, purge air can be discharged to the atmosphere.

6.3 HELIUM LEAK TESTING

The purpose of the chemical leak test is to ensure that the sub slab sample port and probe assembly is properly set and not leaking. A leaking probe assembly could result in a leakage of ambient air into the sample, potentially biasing the sample. Prior to sampling, a chemical leak test will be performed using helium as a tracer gas. The ambient air inside the shroud will be replaced with helium graded at 99.9 percent purity or higher until the atmosphere consists of a minimum of 20 percent helium. It should be noted that concentrations of 60 percent to 80 percent helium have routinely been observed in the shroud during prior field testing. This will be accomplished by inserting Teflon™ tubing through a ¼ inch hole in the shroud and attaching the other end to the helium canister. The helium canister will then be opened, and the shroud atmosphere will be continuously monitored by a Dielectric Technologies Model MGD-2002 Multi-Gas Detector (or equivalent) until the percentage of helium inside the shroud reaches a minimum of 20 percent and the readings on the Multi-Gas Detector (or equivalent) stop increasing. The final helium concentration inside the shroud will be recorded on the Field Data Air Sampling Form. The final helium concentration inside the shroud will be multiplied by 10 percent (0.1) to determine the allowable concentration of helium in the Tedlar™ bag sample. Both the final helium concentration inside the shroud and the calculated allowable concentration in the Tedlar™ bag will be recorded on the Field Data Air Sampling Form (See Attachments).

After the target atmosphere is established, the two-way and three-way stopcocks will be opened to the lung box, which contains a 1 L Tedlar™ bag. An air pump attached to the lung box via Teflon™ tubing will be used to evacuate the existing air inside the lung box, which will in turn cause the 1 L Tedlar™ bag to fill. Once filled, the 1 L Tedlar™ bag will be removed from the lung box and the air inside will be measured using the Model MGD-2002 Multi-Gas Detector (or equivalent) for the presence of helium. The concentration of helium measured inside the Tedlar™ bag will be recorded on the Field Data Air Sampling Form. If the concentration of helium in the sample is below the calculated allowable concentration (i.e., less than 10 percent of the concentration inside the helium shroud), proceed with the mechanical leak test and sample collection as described in Sections 6.4 and 6.5.

Corrective actions to mitigate leaks in the sub-slab soil vapor probe will be performed when the helium concentration in the Tedlar™ bag sample exceeds 10 percent of the starting concentration in the helium shroud. Corrective actions will be performed in the field and will initially involve resealing the probe base with beeswax and repeating the helium leak test. If resealing and retesting fails to produce acceptable leak test results after two attempts, the probe will be abandoned and a new probe will be installed. Samples will not be collected for submittal for laboratory analysis when the helium concentration in the Tedlar™ bag sample exceeds 10 percent of the starting helium concentration in the shroud.

6.4 MECHANICAL LEAK TESTING

The mechanical leak test will be performed immediately after completing the helium leak test. The mechanical leak test will be completed by closing the two-way stopcock and turning the valve on the three-way stopcock to close the tubing connected to the lung box assembly. This will close the connection between the two-way stopcock and the lung box assembly and open the connection between the two-way stopcock and the Summa™ canister. Vacuum test the connections between the Summa™ canister and stopcock by opening the canister valve to place a test vacuum on the assembly for 10 minutes. The start time and initial vacuum, as well as the stop time and final vacuum, will be recorded on the Field Data Air Sampling Form and in the field logbook. If gauge vacuum can not be maintained for 10 minutes, work shall be suspended and all fittings in the sample assembly will be checked. Retest the sample assembly. If vacuum still can not be maintained by 10 minutes, sampling activities will be discontinued until leak can be identified and addressed.

If gauge vacuum was maintained for 10 minutes, close the canister valve and immediately proceed with sample collection as described in Section 6.5. Since the fitting that connects the tubing from the sub-slab probe to the two-way stopcock cannot be leak tested through either the helium or mechanical leak tests, this fitting will be sealed with Teflon™ tape and beeswax.

6.5 SAMPLE COLLECTION

Sample location information, meteorological conditions (temperature, barometric pressure, wind speed/direction, and relative humidity), and results of the field screening analysis shall be recorded on a Field

Data Air Sampling Form. Meteorological data will be obtained online from the nearest National Weather Service measuring station. Digital photos will be taken of each sample location and sample assembly.

Open the sample canister valve to begin sample collection. The time and initial vacuum when sample collection starts shall be recorded on the Field Data Air Sampling Form. The laboratory-provided flow regulators will be calibrated for a 5- to 10-minute sample duration, which correlates to a flow rate of 100 to 200 mL/min. Close the sample canister valve when the vacuum gauge indicates approximately 5 inches Hg (mercury) of vacuum remain in the canister. Sample collection should take approximately 5 minutes for a 1L Summa™ canister connected to a 200 mL/min flow regulator. The time sample collection was stopped and final vacuum shall be recorded on the Field Data Air Sampling Form. Remove the flow regulator/particulate filter and vacuum gauge assembly and replace the laboratory-supplied brass plug on the canister. Disconnect the sample tubing assembly and replace the plug on the soil vapor probe.

Label the sample canister and record on the COC the sample name, date and time the sample was collected, the canister and flow controller serial numbers, and the final vacuum gauge reading. Samples shall not be chilled or subjected to extreme temperature or pressure fluctuations. Samples will be shipped for analysis of VOCs by USEPA Method TO-15.

6.6 QUALITY CONTROL

QC samples will be collected during soil vapor sampling activities. Trip blanks and field duplicates will be collected as necessary. Field duplicates will be collected at the rate of one duplicate sample per 20 soil vapor samples.

A trip blank, consisting of an unopened evacuated canister, will be shipped with the sub-slab vapor samples with each sample shipment. Trip blanks can consist of either unopened fully evacuated canisters or canisters that have been fully charged with zero grade air by the laboratory. Since a fully charged canister has no vacuum with which to pull contaminants into the canister, a fully evacuated canister has a better likelihood of capturing potential transit-related contamination. The trip blank will be provided by the laboratory.

7.0 EQUIPMENT DECONTAMINATION PROCEDURES

All decontamination will be performed according to SAS-04-04.

8.0 INVESTIGATION-DERIVED WASTE (IDW)

The vapor probe installation and sampling will generate small amounts of solid IDW including, concrete dust, gloves, and tubing. This material will be bagged and disposed of as a municipal waste in accordance with applicable regulations. No liquid IDW will be generated. Further discussion of IDW can be found in Section 9 of the *Multi-Site Field Sampling Plan, Former Manufactured Gas Plant Sites, Revision 3", February 20, 2008.*

APPENDIX G

MULTI-SITE FIELD SAMPLING PLAN, REVISION 4
(INCLUDED ON CD)

MULTI-SITE FIELD SAMPLING PLAN
FORMER MANUFACTURED GAS PLANT SITES

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Revision 4
September 8, 2008

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APPENDICES

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ACRONYMS

Acronyms used in this Multi-Site Field Sampling Plan.

°C	Degrees Celsius
°F	Degrees Fahrenheit
µm	Micrometer / Micron
µmhos/cm	Micromhos Per Centimeter
ASTM	ASTM International (fka American Society for Testing and Materials)
AVS SEM	Acid Volatile Sulfides-Simultaneously Extracted Metals
BERA	Baseline Ecological Risk Assessment
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CA	Cost Analysis
cm	Centimeter
COC	Chain-of-Custody
COPC	Chemicals of Potential Concern
CPT	Cone Penetrometer Technology
CSM	Conceptual Site Model
DET	Diffusion Equilibration in Thin Films
DNAPL	Dense Non-Aqueous Phase Liquid
DQO	Data Quality Objective
DPT	Direct Push Technologies
EE	Engineering Evaluation
ESB	Equilibrium Partitioning Sediment Benchmark
eV	Electron Volt
EZ	Exclusion Zone
FAM	Field Analytical Method
FEMA	Federal Emergency Management Agency
FOP	Field Operating Procedures
FSP	Field Sampling Plan
GPS	Global Positioning System
GW/SW	Groundwater / Surface Water Interface
HSA	Hollow Stem Augers
HAZWOPER	Hazardous Waste Operations and Emergency Response
HASP	Health and Safety Plan
HDPE	High-Density Polyethylene
ID	Inside Diameter

ACRONYMS (CONT'D)

IDW	Investigative Derived Wastes
Illinois EPA	Illinois Environmental Protection Agency
ITRC	Interstate Technology and Regulatory Council
LDPE	Low-Density Polyethylene
LIF	Laser Induced Fluorescence
LNAPL	Light Non-Aqueous Phase Liquid
m	Meter
MGP	Manufactured Gas Plant
mg/L	Milligrams per Liter
MIP	Membrane Interface Probe
mL	Milliliter
mL/min	Milliliters Per Minute
MS/MSD	Matrix Spike/Matrix Spike Duplicate
mV	Millivolts
NAPL	Non-Aqueous Phase Liquid
NAVD88	North American Vertical Datum of 1988
NTU	Nephelometric Turbidity Unit
OD	Outside Diameter
ORP	Oxidation / Reduction Potential
OSHA	Occupational Safety and Health Administration
OWSER	Office of Solid Waste and Emergency Response
PAHs	Polynuclear aromatic hydrocarbons
PCB	Polychlorinated Biphenyl
PDB	Polyethylene Diffusion Bag
PID	Photoionization Detector
POTW	Publicly-Owned Treatment Works
PPE	Personal Protective Equipment
ppm	Parts Per Million
PQLs	Project Quantitation Limits
PVC	Polyvinyl Chloride
PVD	Passive-Vapor-Diffusion
PVOC	Petroleum Volatile Organic Compound
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control

ACRONYMS (CONT'D)

QAM	Quality Assurance Manual
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAF	Risk Assessment Framework
RBP	Rapid Bioassessment Protocols
RI/FS	Remedial Investigations and Feasibility Studies
ROST	Rapid Optical Screening Tool
Settlement Agreement	Settlement Agreement and Administrative Order on Consent
SI	Site Investigation
SIM	Selected Ion Monitoring
SLERA	Screening Level Ecological Risk Assessment
SOP	Standard Operating Procedure
SSA	Solid Stem Auger
SOW	Statement of Work
SPE	Solid-Phase Extraction
SPP	Systematic Planning Process
SSWP	Site-Specific Work Plan
TarGOST	Tar-specific Green Optical Screening Tool
TOC	Total Organic Carbon
µS/cm	Microsiemens per centimeter
USCS	United Soil Classification System
USDOE	United States Department of Energy
USGS	United States Geological Survey
USEPA	United States Environmental Protection Agency
UVOST	Ultra-Violet Optical Screening Tool
VOA	Volatile Organic Analyte
VOC	Volatile Organic Compounds
WDNR	Wisconsin Department of Natural Resources

1 INTRODUCTION

1.1 Background

This Multi-Site Field Sampling Plan (FSP) was prepared in accordance with the respective Statement of Work (SOW) attached to the Settlement Agreement and Administrative Order on Consent (Settlement Agreement) between the United States Environmental Protection Agency (USEPA) and Wisconsin Public Service Corporation (WPSC) effective May 5, 2006; The Peoples Gas Light and Coke Company (PGL) effective June 5, 2007; and North Shore Gas Company (NSG) effective July 23, 2007. The Multi-Site FSP addresses former manufactured gas plants (MGPs) operated by WPSC, PGL and NSG, collectively the Company. Integrys Business Support, LLC (IBS) is managing the work in the Settlement Agreement on behalf of the Company.

Manufactured gas was utilized for residential and industrial lighting, heating, and other uses from the early 1800s through the mid 1900s, before electricity and/or natural gas were commercially available. Gas was produced by various means, including coal carbonization (also known as coal gasification), carburetted water gas, and oil gas. Coal carbonization was the simplest process wherein coal was heated in an airtight chamber called a retort to approximately 2,200 degrees Fahrenheit (°F), causing the coal to decompose into gas, tar and residual coke. When steam was added to the coke and coal in the retort, water gas was produced. The addition of oil to the process resulted in a gas with a higher thermal content, called carburetted water gas. Production of gas using heavy oils such as naphtha as feedstock without coal (popular in areas with more oil than coal, such as the west coast) resulted in yet another type of gas called oil gas.

Regardless of the method of gas production, the gas produced then had to be cooled and purified before distribution to consumers. The gas was first passed through a series of condensers, tar baths, water baths, and washers to remove ammoniacal liquors and tars. The gas was then passed through a purifier to remove impurities such as sulfur, carbon dioxide, cyanide, and ammonia. Dry purifiers used trays and sieves containing lime or hydrated iron oxide mixed with wood chips. The gas was then stored in large holders on the MGP property prior to distribution for lighting and heating.

The MGP manufacturing processes resulted in the production of various byproducts, some valuable and some simply waste. Coke could be reused in the retort ovens and coal tar was often burned on the MGP property for energy recovery, sold off-site and beneficially reused for roofing, wood treatment, and road paving. Purifier box wastes however, were often dispersed throughout the MGP property. Releases of these byproducts on MGP properties were later discovered to have potential for impacting soil and groundwater with petroleum hydrocarbons, polynuclear aromatic hydrocarbons (PAHs), cyanide, and other compounds.

When natural gas became widely available with the advent of interstate pipelines in the 1940s and 1950s, MGPs became obsolete and plants were dismantled or simply razed. Because little or no documentation often exists concerning how these facilities were decommissioned, the assessment of former MGPs requires investigators to reconstruct historical MGP operational data. Experience evolving since the mid-1980s has shown that soil and groundwater are often impacted at many MGP properties and some, located adjacent to surface water bodies, may include sediment impacts.

1.2 Sampling Objectives

The overall goal of the Remedial Investigation and Feasibility Study or Engineering Evaluation and Cost Analysis (Study) process is to collect sufficient data to characterize the nature and extent of impacts and risks at each of the sites and provide a feasibility study for a range of potential remedial options leading to the selection of a proposed remedial action at each site. The Company sites encompassed within this FSP exhibit two areas affected by MGP residuals to varying degrees: 1) the former MGP properties where manufactured gas operations occurred and adjacent properties, and 2) adjacent surface water bodies. Previously obtained site investigation (SI) data will be supplemented, as appropriate, with additional investigations necessary to evaluate potential exposure pathways, if any, and to characterize the nature and extent of contamination, evaluate potential remedial alternatives protective of human health and the environment.

This FSP is intended to ensure that sample collection and analytical activities are conducted in accordance with acceptable protocols that meet Data Quality Objectives (DQOs) as established in the Multi-Site Quality Assurance Project Plan (QAPP). The information presented in this FSP and in the QAPP will enable field personnel to collect field samples and measurements in a manner that meet the project DQOs.

Accordingly, the intent of this FSP is not to detail specific sampling locations and investigative methods to be employed at each of the Company MGP sites. Rather, the FSP identifies the probable range of investigative approaches likely to be employed along with appropriate procedures and protocols that will form the basis for developing and implementing Site-Specific Work Plans (SSWPs).

1.3 Site-Specific Work Plans

1.3.1 Technical Approach

The SSWPs will follow the Triad approach, to identify and manage decision uncertainties in relation to the Generalized Conceptual Site Model (CSM). The Generalized CSM will be refined and included as part of the SSWP on a site-by-site basis to provide the framework for a concise statement of project goals. Site project goals will be used to develop a field-decision framework for SSWPs, which will identify an approach to determine sample locations, types, frequencies, collection methods, and field analysis. The CSM will be updated as data are generated. SSWPs or site-specific RI Reports will present these data in cross-sections or other visualizations, as appropriate, to evaluate potentially complete pathways.

Innovative sampling tools may be employed, as appropriate, to obtain quality data in an expedited manner consistent with *'A Resource for MGP Site Characterization and Remediation'* (OSWER Publ. EPA 542-R-99-005). The Generalized CSM will be updated and included as part of the SSWP as field data are evaluated. Real-time data generation and interpretation will be used in a flexible field-decision framework to modify field activities based on changes in site-specific conditions. The SSWPs will detail the decision-process and site knowledge that will be utilized on a real-time basis to determine sample type, location, frequency, and analytes. A generic decision tree diagram is provided as Figure 1. Field staff must maintain close communication with project oversight team members during implementation of the dynamic SSWPs.

Table 1 provides an example Sampling and Analysis Summary that will be detailed in SSWPs with figures depicting previous and proposed initial sampling locations, as appropriate. The following sections summarize other key elements of dynamic SSWPs.

1.3.2 Project Personnel

1.3.2.1 Project Team

The SSWPs will identify key project staff responsible for project planning, data and decision quality, and final work products, consistent with the QAPP. Personnel qualifications will be provided in SSWPs, when applicable. If individuals are not identified in a SSWP, general qualifications for the team member position will be detailed. Team members will meet suggested experience and qualification levels identified by USEPA (2003 OWSER No. 9200.1-40, 540/R-03/002). A generic team member diagram is included as Figure 2 Generic Communication Strategy Diagram.

1.3.2.2 Subcontractors

When practical, SSWPs will identify specific subcontractors and will provide subcontractor qualification information. If a specific subcontractor is not identified in a SSWP, the SSWP will identify the required qualifications for each type of subcontracted activity. SSWPs will include subcontractors within the Communication Strategy and Decision-Making Process.

1.3.3 Communication Strategy

SSWPs will provide a site-specific communication strategy, which will identify project communication flow, frequency, and documentation requirements between potentially responsible parties/responsible parties, regulators, project managers, field personnel, contractors, and others as identified on a site-specific basis. Key Decision-Making Process team members will be identified by name and methods of contact. The communication strategy will be provided in a manner that visually depicts communication hierarchy and required reporting periods.

1.3.4 Decision-Making Processes

The Decision-Making Process will identify decision steps that will be based on field data, require regulatory agency discussion for implementation, and project management approval. The process will identify key steps and decision points at which point field team(s) will adjust the track of investigation as

appropriate based on field conditions and the established hierarchy for decision-making and management responsibilities.

Decision steps identified will include authorization hierarchy for steps such as:

- Criteria for sample location, type, analysis, etc.;
- Criteria to conclude a phase or type of sampling;
- Criteria for location and construction of groundwater monitoring wells;
- Cessation of sampling for reasons other than achieving SSWP goals; and
- Changes in sampling and/or analytical method(s).

1.3.5 Data Exchange

SSWPs will identify data required for decision-making, establish formats, and schedule for the exchange of data. Data requirements will include data types, schedule, and format.

2 SAMPLE LOCATIONS

Several of the Company facilities and adjacent surface waters have been the subject of multiple phases of investigations for MGP residuals. In some cases, contaminant sources present in soil have been remediated. These previous SI activities have focused on:

- Evaluation of historic MGP operations and property development through time;
- Locations of historic MGP structures, process areas, subsurface piping and/or utilities;
- Evaluation of the extent of MGP residuals in soil; and
- Evaluation of the extent of affected groundwater plumes.

Site-specific Completion Reports will be submitted to USEPA for review and approval. The Completion Reports will summarize the results of previously performed SI activities and will be used to identify areas and/or media of each Site that may require additional Study activities. Previously obtained SI data will be evaluated for usability in the SSWPs and used to direct locations of further Study sampling, as appropriate, of all applicable media. Supplemental sample locations will be evaluated based on the needs and data gaps identified in the Site-specific CSM and risk assessments. The data needs of the risk assessments will consider current land use as well as a reasonable range of future land uses that also consider the site's location, history, neighboring land use and community input. Elements used to identify and develop the Site-specific CSM and risk assessments are discussed in the Generalized CSM.

Samples will be collected as necessary and at an appropriate frequency to support the Site-specific CSM and risk assessments in relation to the nature, magnitude, and extent of MGP-related impacts. Sample media will be identified in SSWPs and may include:

- Surface soil (0 to 2 feet below ground surface (bgs) or as determined in SSWPs) and subsurface soil (vadose zone material below surface soil);
- Surface Water;
- Groundwater;

- Sediment; and
- Air.

Samples may also be collected for waste characterization as well as physical and/or engineering parameters that may be necessary to screen remedial options for the Study.

3 FIELD MOBILIZATION AND SITE ACCESS

Prior to initiating field activities, the Study Leader will review the Site-specific project goals, objectives and scope with the Field Sampling Team. The Field Sampling Team will review the HASP, SSWP, and contractor's/consultant's field SOPs. If necessary, field activity area(s) reconnaissance may be performed to familiarize field staff with field conditions, identify access points, and locate proposed initial sampling points.

3.1 Site Access

Controlling field activity area access is of utmost importance to protect the public from exposure to contaminants and physical hazards at the Site during field investigation activities. All visitors must check in with the Field Manager before being allowed into the field activity area. Visitor information (e.g., affiliation, reason for visit, etc.) will be documented in the field notebook. Unauthorized visitors will not be allowed in field activity areas. Personnel entering the field activity area will review the HASP and the Site-specific elements included in the SSWP.

Visitors will not be allowed to enter work area exclusion zones without permission from the Project Manager. The work area exclusion zone will be secured with either traffic cones/barriers, and/or caution tape. Test pits that may be excavated during field activities will be backfilled before the end of the day to eliminate physical hazards as well as the possibility of exposure to contaminants when work is not taking place.

3.2 Mobilization Activities

The IBS Project Coordinator will notify USEPA no less than 15 business days prior to beginning field activities. Mobilization activities may include:

- Prepare a Site contact list, including the names of field team personnel and subcontractors, affiliation, and contact numbers for distribution to all field team members and the Study Leader;

- Receive permission to access privately and/or publicly owned properties, if required, to perform off-property investigations. Where feasible, off-property access will be coordinated within schedule constraints, such as limiting activities during school hours, peak business hours, etc.;
- Clear underground utilities. If utilities are identified, a Site meeting may be arranged with utility representatives and/or initial sampling locations may be adjusted (SOP SAS-005-01);
- Evaluate access for accessibility to sampling locations with proposed equipment;
- Coordinate subcontractors which may include drillers, laboratories, surveyors, etc. and review scope of work, schedule, and discuss special equipment needs;
- Acquire proper personal protective equipment (PPE);
- Review analytical requirements, request appropriate sampling containers from the analytical, toxicity, and/or geotechnical laboratories, and discuss delivery/pickup of coolers/packages, including weekend deliveries;
- Secure and verify working conditions of field instruments in accordance with their respective SOPs;
- Load appropriate equipment and supplies to perform the field activities in accordance with procedures outlined in SOP SAS-02-01;
- Coordinate the management/disposal of investigative waste;
- Prepare equipment staging areas, if necessary; and
- Locate survey information or identifying the need to survey previous and/or proposed initial sampling locations. Surveys, if necessary, will be performed using the coordinate system specified in the SSWP.

3.3 Site Safety

Field activities will be conducted in accordance with the Multi-Site HASP and Site-Specific HASP elements.

3.4 Demobilization Activities

USEPA will be notified of completion of field activities in writing. Demobilization activities may include:

- Disposal of investigation derived waste (IDW) (Section 9);
- Additional Site survey tasks, if appropriate (SOP SAS-02-02);
- Site restoration, if appropriate; and
- Data management activities (SOP SAS-01-02).

4 DATA COLLECTION PROCEDURES

4.1 Field Standard Operating Procedures

SOPs are included as Appendix A. These SOPs will be referenced in the development of SSWPs for each of the Company's former MGP Sites.

4.2 Soil Sampling

This section describes soil sampling collection methods and requirements. Soil sampling and field screening methods may be evaluated and chosen to maximize the effectiveness of site characterization and limit heterogeneity uncertainties in the CSM. Sampling option speed, cost, accessibilities, and associated field analytical method (FAM) will also be evaluated during sampling technique selection. General soil sample options and characteristic comparisons are presented on Tables 2 and 3.

A qualified geologist or engineer will classify soils utilizing the United Soil Classification System (USCS) in accordance with ASTM International (ASTM) Standard Procedure ASTM D2488 and will record soil sampling data, field conditions, sampling depths and other sampling details in accordance with QAPP Section 1.7, SOP SAS-05-02 and the SSWP.

4.2.1 Data Uses

Soil data may be collected to support screening level ecological risk assessment and baseline ecological risk assessment, human health risk assessment (consistent with the CSM), delineation of the extent and magnitude of contamination (laterally and vertically), evaluation of remedial alternatives, potential to affect groundwater, and waste characterization.

Surface soil data will be collected from 0 to 2 feet bgs (or as otherwise defined in SSWPs) and will be used to support the human health incidental ingestion, dermal and inhalation exposure routes, if

applicable for each human health receptor. In addition, surface soil samples will be used in the ecological risk assessment, if required to evaluate potential risk in the upland portions of the Sites to terrestrial small mammals.

Sub-surface soil data will be collected from 2 feet bgs to generally 6 feet bgs (or as otherwise defined in the SSWPs) to facilitate installation of sub-surface utilities and will be used to support the human health dermal and inhalation exposure routes for the construction worker human health receptor. Deeper sub-surface soil samples may be collected to evaluate the vertical extent of MGP residuals or evaluate remedial alternatives.

4.2.2 Surface Soil Samples

Surface soil samples may be collected from soil borings, soil probes, test pits, hand augers, hand tools (shovel, trowel, spatulas, etc.), or similar apparatus (SOPs SAS-06-01, SAS-06-02, and SAS-05-06). Surface soil samples may be collected as a composite sample, consisting of an appropriate number of sub-samples or increments over an appropriate area (as determined on a site-specific basis) or as discrete samples when collected from soil boring locations. Samples collected for volatile organic compound (VOC) analysis will be discrete samples. The use of composite versus discrete samples will be identified in the SSWP. If gravel or cobbles are encountered at the surface, the sample will be collected from soil just below the gravel/cobbles. If the surface is vegetated, the surface soil sample will be collected just below the root zone.

Field photoionization detector (PID) screening for VOCs may be conducted on soil samples in accordance with the SSWP and field SOPs. Samples may be screened with a hand held PID equipped with a 10.6 or 11.7 eV lamp. The field analysis data and other visual observations of affected soil, as described in SOP-SAS-05-02, may be used to select soil samples for field or fix-laboratory analysis.

4.2.3 Sub-Surface Soil Samples

Sub-surface soil samples may be collected from soil borings, soil probes, test pits, hand augers, hand tools (shovel, trowel, spatulas, etc.), or similar apparatus (SOPs SAS-06-01, SAS-06-02, and SAS-05-06).

Sub-surface soil samples will generally be collected as discrete samples, typically over a 6-inch interval or as determined based on observed soil horizons or indications of MGP residuals.

Field PID screening for VOCs may be conducted on soil samples in accordance with the SSWPs and field SOPs. Samples may be screened with a hand held PID equipped with a 10.6 or 11.7 eV lamp. The field analysis data and other visual observations of affected soil, as described in SOP-SAS-05-02, may be used to select soil samples for field or fix-laboratory analysis.

4.2.4 Test Pits

When access permits, test pit excavation may be the primary means to locate and evaluate shallow (less than 15 feet bgs) MGP structures, activity areas, and the nature and magnitude of residuals. Test pit excavations will be field logged in accordance with the SSWP and SOP SAS-05-06.

Excavations may be performed with a backhoe or hand shovel. Decontamination of equipment shall occur after an excavation is completed or daily following the procedures described in SOP SAS-04-04.

Analytical samples generally will not be collected within test pits excavated to evaluate utility corridors, structures, etc. Test pits excavated for other purposes may be selected for analytical sampling, as determined in the SSWPs, considering the DQOs. SSWPs will detail the sampling requirements on a site-by-site basis. Soil samples may be collected from test pits using hand tools (spoons, trowels, and/or shovels), clean spatulas, and sample containers as described in SOP SAS-05-06.

Soil samples may be collected from the walls or based of the test pit. Sampling directly from the excavator bucket is not preferred. However, soil samples may be collected directly from the excavator bucket after removal from the excavation or from the soil stockpile if the test pit depth is deeper than can be safely accessed, unstable side walls, or would otherwise require a confined space permit. If sampling from an excavator bucket is required, soil samples will be collected from the center of the bucket as soon as the bucket has been brought to the surface to minimize volatilization. Procedures for soil sample collection are described in SOPs SAS-05-06, SAS-06-01, and SAS-06-02.

In general, field crews shall never enter an excavation without proper safety precautions and shoring. After test pit excavation, logging and sampling are completed, test pits will be backfilled in accordance with SOP SAS-05-07 or as specified in the SSWP.

4.2.5 Soil Borings

Soil borings may be advanced by multiple drilling techniques as detailed in SOP SAS-05-02 and/or the SSWPs and include:

- Direct push technology (DPT);
- Hollow-stem auger (HSA);
- Solid-stem auger (SSA);
- Continuous coring;
- Sonic Drilling;
- Air Rotary Drilling; and
- Mud Rotary Drilling.

In general, HSA, SSA, sonic, and rotary drilling methods yield low sample collection rates and increased costs over DPT. The SSWPs will provide the rationale for selecting a specific method. These drilling methods may be utilized, as specified in SSWPs, for construction of monitoring wells that require well diameters of 2-inches or greater or for testing that requires large sample volume, such as bench-scale testing for various remedial alternatives. These drilling techniques may also significantly increase investigative waste volume and may be utilized primarily when DPT sampling is not feasible due to access, refusal, and/or sampling depth.

Soil samples will generally be collected in 2-foot increments on a continual or 5-foot sampling basis, with the exception of sonic drilling and continuous coring, which yields a continuous soil core. Samples will be logged by a field engineer, geologist, or qualified geotechnical/geophysical equipment operator as specified in SSWPs.

4.2.6 Subsurface Probes

A variety of probing devices are available that may provide semi-qualitative subsurface data that are briefly described below. SOPs will be developed, as needed, in the event these technologies are deemed appropriate and suitable for the SSWPs.

4.2.6.1 Conductivity Probe

The conductivity probe is a geophysical tool that is deployed with DPT probes. For cone penetrometer technology (CPT) probes, the conductivity probe is typically placed above the standard penetrometer tip. Conductivity probes are also available as single drive tips. The probe measures resistivity in adjacent soil with probe depth, producing a continuous conductivity log. Conductivity variations are related to stratigraphic changes, yielding detailed lithologic logs for expedited field characterization.

4.2.6.2 Cone Penetrometer

CPT is commonly used in geotechnical activities to evaluate various physical properties of the soil in the subsurface. CPT sampling depth is generally increased with the weight of the CPT vehicle, which in turn limits the accessibility of CPT equipment. As a CPT probe is advanced through the subsurface at a predetermined rate, the probe cone measures tip resistance and the probe side (sleeve) measures soil friction. Probe data may be correlated to specific Site stratigraphy, if resistance and friction are directly compared to analytical soil data. CPT technology is capable of obtaining discrete soil cores and water samples.

CPT probes may provide pore pressure data with a pressure transducer located within the probe, which is connected to a ceramic screen that is generally mounted above the cone. Pore pressures may be used to evaluate soil hydraulic conductivity and soil type.

Drawbacks: The CPT does not directly measure soil types or chemical species. In addition, if the intention is to use the stratigraphy capability, it needs to be calibrated against one or more conventionally logged boreholes (drilled or direct push continuous soil sampling). However, a CPT rig can be fitted with

direct push continuous coring capabilities so only one piece of equipment is required to conduct a survey. CPT cannot be used in hilly areas.

4.2.6.3 Laser Induced Fluorescence

Induced fluorescence provides qualitative in-situ data that measures the fluorescent response of a chemical to an ultraviolet light source (lasers and mercury vapor lamps). The laser induced fluorescence (LIF) probe is typically developed on a CPT rig for detection of contaminants that fluoresce, consisting primarily of PAHs among the MGP contaminants of potential concern (COPC). Several natural minerals (e.g., calcite) fluoresce also. Therefore, background levels must be checked to ensure probe calibration.

LIF probes typically read and analyze one sample interval per second with a typical advancement of a CPT probe yielding a reading for every 0.2 feet.

An approximate correlation between LIF data and analytical contaminant levels may be created if soil cores are collected and quantitatively analyzed (field or fixed-laboratory) adjacent to CPT data areas that indicated probable contaminants. Potential bias and interferences associated with the LIF probe include:

- Increasing concentration are not always read by the LIF probe as linear changes; and
- The LIF probe is sensitive to soil lithology changes (grain size, mineralogy, moisture, and surface area).

LIF probe response to coal tar is relatively weak (USEPA 2004 EPA 542-R-04-017) as the probe does not readily read heavier end aromatics. Therefore, the probe is typically calibrated to multiple components to ensure the coal tar is not missed. LIF improvements continually evolve and prospective vendors may be consulted, as appropriate, to evaluate potential applications.

4.2.6.4 In-Situ Camera

In-situ camera probes (GeoVIS®, videocone, etc.) produce visual images of subsurface soils. The images are collected as the probe is advanced and encoded with depth and time readings. GeoVIS images approximately a 2 by 3 mm area with a resolution as small as 10 μm, frequently showing visual evidence of non aqueous phase liquids (NAPLs), other than clear liquids. Camera and LIF probe may be deployed

in the same borehole; however, probe speeds are typically different, occasionally preventing dual deployment. Prospective vendors may be consulted, as appropriate, to evaluate the use of multiple probes.

4.2.6.5 Membrane Interface Probe

The membrane interface probe (MIP), developed by Geoprobe®, measures total VOCs in soil, which is useful in site characterization in conjunction with probes and analytical data that provide specific contaminant concentrations. The probe is a semi-permeable membrane impregnated into a stainless steel screen. The screen is placed in direct contact with the soil sample interval and the membrane is heated to between 100 and 120 degrees Celsius (°C). Potential contaminants in soil migrate across the membrane, and are transported to the surface with a carrier gas (typically nitrogen or helium). FAMs typically utilized to analyze the MIP gas include PIDs, flame ionization detectors, electron capture detectors, and ion-trap mass spectrometers. The presence of NAPL may require dilution of the gas stream, reducing the number of samples analyzed per day.

4.2.7 Borehole Abandonment

All boreholes will be abandoned and documented in accordance with ASTM standard procedures, the SSWP, state specific regulations (if applicable), and SOP SAS-05-05. Boreholes will be completely filled with bentonite granules, bentonite chips, bentonite slurry, etc. Sealing material will be placed via gravity with the exception of grout, which will be placed from the base of the borehole with a tremie pipe. Sealing material will be placed in the borehole in a manner that detects and prevents bridging and displaces the borehole water column, if present. Borehole bentonite granules and chips will be hydrated in lifts if the borehole is dry or does not contain sufficient borehole water. Abandonment documentation will be provided to USEPA in subsequent reports.

Particular attention will be given to boreholes that penetrate confining units or extend through NAPL, particularly if they penetrate a lower confining unit. Abandonment of these boreholes may require over-drilling and additional options (e.g. grout injection) for sealing material explored to ensure a preferential migration pathway is not created at the borehole migration. Borings in which NAPL is observed may be abandoned and relocated, depending on site-specific DQOs, to minimize potential NAPL migration.

4.3 Geophysical Methods

4.3.1 Overview

Geophysical data collection provides quantitative and qualitative data on physical properties of the subsurface materials, such as conductivity/resistivity, and density, etc. Geophysical data may be collected and evaluated as surface surveys, surface to borehole, borehole-to-borehole, single borehole, and water-born methods. For many surface and some soil borehole survey methods, interpretation requires the geophysical data be calibrated with nearby physical data to accurately describe subsurface characteristics. Data may be presented as graphs, plan view contour maps, 2-dimensional cross-sections, or in some cases, three-dimensional imaging software.

Geophysical data resolution and accuracy depends on the degree of interpolation between measured points, depth (resolution generally decreases with depth), and the degree of physical property contrast between geologic structure(s) and targets in the subsurface. These characteristics will be integrated into geophysical field method evaluation. Geophysical data may be used to begin data gathering or enhance existing data on:

- Geologic lithology, thicknesses, and bedrock surface elevations;
- Aquifer characterization (depth to water table, water quality, fracture mapping);
- Dense non-aqueous-phase liquid (DNAPL) mass location(s) when the mass is substantial enough to cause a resolvable change in physical characteristics of the host matrix;
- Buried structure location and depth;
- Bathymetry;
- Sediment thickness; and
- Sediment surface structures and morphology.

Resources for evaluation of geophysical methods are summarized on Tables 4 and 5. Site-specific objectives and requirements will be considered in selecting geophysical methods. On a site-specific basis,

select geophysics contractors may be requested to demonstrate applicability of these methods prior to final selection.

4.3.2 Upland Applications

In general, geophysical techniques may be used to assist in field characterization in areas other than water bodies (Upland Areas). Geophysical techniques may include a natural gamma survey and an induction log electro magnetic survey. The appropriate borehole application methods will be identified in the SSWPs.

4.3.3 Sediment Applications

Prior to collection of sediment samples, surface water body bathymetry and the location of soft sediment deposits may be evaluated through hydrographic surveys, including multi-beam sonar (bathymetry), sub-bottom profiling (sediment thickness), and side scan sonar. The bathymetric survey will map the sediment bed elevation, while the side scan sonar survey will identify sediment surface morphology and the location of potential submerged obstructions. In addition, the sub-bottom profiling survey may help identify areas with accumulation of soft sediment. Sediment stratigraphy and thickness may be confirmed through sediment poling during sediment sampling. The bathymetric survey may be performed prior to the side scan and sub-bottom surveys as the bathymetry data may be used to select the orientation of side scan sonar transects. The surveys will be performed in accordance with the subcontractor's technical field operating procedures (FOPs), to be included in SSWPs.

The results from the hydrographic surveys will provide an assessment of the extent and thickness of soft sediment that may be used in evaluating remedial options. Data collected during these activities may be used to identify appropriate locations to collect sediment samples. For river sediment sampling, bathymetry data may be utilized with stream flow measurements to calculate flow velocities and discharge. Flood information available from Federal Emergency Management Agency (FEMA) may be used to assess flood flow frequency, volume, and discharge velocities for evaluation of potential scour in river channels, if applicable.

Geophysical survey quality assurance / quality control (QA/QC) requirements to achieve CSM goals will be presented in SSWPs.

4.3.4 Base Mapping and Survey Control

Topographic and bathymetric surveys may be utilized to develop base maps to provide accurate data essential for the CSM and in support of final engineering design. Survey data and locations will be in latitude/longitude (degrees, minutes, and seconds), state-specific plane coordinate system, or by other means specified in the SSWP for horizontal control. Vertical control will be referenced to the system or method specified in the SSWP. Base maps may be used for the following:

- Depiction of utility data, derived from outside sources, on an area wide basis;
- Depiction of public and private shoreline features that will be incorporated into the CSM and utilized for evaluation of potential remedial work (docks, bulkheads, etc.);
- Sediment elevation depiction;
- Plotting proposed sediment sample location(s) on an x-y-z coordinate system;
- Current distribution and volume estimates of soft sediment;
- Construction base map for remedial action infrastructure and facilities (docks, slurry piping, dewatering plant, wastewater treatment plant, etc.); and
- Establishing a construction grid system upon which engineering calculations will be based.

4.4 Groundwater Sampling

4.4.1 Overview

This section describes the groundwater sampling collection methods and requirements. Groundwater sampling may be completed to delineate the extent (both laterally and vertically) of MGP affected areas and support risk evaluations (consistent with the CSM). Applicable DQOs from the QAPP will be identified and considered when groundwater sampling is required, so that the methodology selected and

resulting data will satisfy the DQOs. This may be especially significant when the existing monitoring network requires additional points to assess the extent of groundwater impacts

Installation of the groundwater sampling points (whether a temporary or permanent device/well), as well as the particular sampling technique(s) may be evaluated and chosen to maximize field characterization and limit heterogeneity uncertainties in the CSM (SOP SAS-05-03). Sampling option speed, cost, accessibilities, and associated FAM will also be evaluated during sampling technique selection. General groundwater sample options and characteristic comparisons are presented on Table 2 and 3. Sampling activity details will be recorded in field logbooks and sampling sheets as described in the QAPP - Section 1.7, the SSWP, and SOPs SAS-08-02, SAS-08-03

4.4.2 Data Uses

Groundwater monitoring shall be performed at each Site at the frequency specified in the SSWP. Sites in which an upland remedial action has been completed will be evaluated for post-remediation trends in MGP residual concentrations and/or to evaluate whether conditions may be favorable to remedial alternatives and trend analysis. Sites in which an upland remedial action has not been implemented will be monitored to establish a pre-remediation baseline.

Groundwater samples will be collected as grab samples or from temporary monitoring wells during Study activities and from permanent groundwater monitoring wells during Study activities and post-remediation monitoring. Monitoring wells are constructed to characterize the nature and extent (vertically and laterally) of MGP residuals, evaluate groundwater flow direction and use, evaluate hydraulic conductivity and vertical gradients, and compile data for use in groundwater modeling.

Groundwater sampling data will be recorded on field notes and forms, which will include Sample Control Logs, Daily or Weekly Field Logs, chain of custody (COC) Sheets, and Groundwater Monitoring Field Forms.

4.4.3 Water Level Elevation Readings

Groundwater elevation readings will be collected prior to well or borehole purge activities. Permanent equipment will be stored within the water column, if possible, in a manner that allows water levels to be measured without removing dedicated equipment. If permanent equipment cannot be feasibly stored within the water column, the equipment will be tied above the anticipated stabilized water elevations. The equipment may be removed prior to collecting elevation data without disturbance of the water column or may remain in place during water level measurements. Groundwater elevation readings will be collected to the hundredth of a foot in accordance with the SSWP and SOP SAS-08-01 and will be recorded on in the field logbook and/or on the appropriate field form.

In general, depth to water level measurements will not collected with standard water level probes from monitoring wells with tar. Water levels in these wells may be approximate to the tenth of an inch with a weighted standard measuring tape. Groundwater elevations from up-, side-, and downgradient from wells with tar and l all other site wells may be sufficient for groundwater flow interpretation. Alternatively, water levels and NAPL (LNAPL and DNAPL) measurements may be collected as described in SAS-08-01.

4.4.4 Groundwater Grab Samples

Numerous grab groundwater sampling techniques for use with DPT and borehole drilling techniques are commercially available. A number of available systems are summarized below; the spectrum of sampling options is too wide to detail entirely below and continually evolves. Commercially available sampling techniques will be evaluated during planning phases and detailed in SSWPs.

4.4.4.1 HydroPunch® Small Diameter Telescoping Screen

A small diameter-telescoping screen used to take depth discrete groundwater samples, commercially available as HydroPunch®, among others. The screen may be deployed using DPT (including CPT) or HSA rigs. A stainless steel tip and rod are driven to a desired sampling. A stainless-steel sampling screen is exposed when the probe sleeve is retracted slightly. Groundwater enters the inter probe casing and a groundwater sample is collected with a small-diameter bailer, peristaltic pump, or small diameter bladder pump.

The HydroPunch® II may be equipped with an internal double ball valve sample device. As water enters the probe and sample device, hydrostatic pressure moves the bottom ball valve up and groundwater fills the sample container (typically 1-liter volume). As the probe is withdrawn with the filled sample container, the top valve prevents water from entering the chamber, and the bottom valve prevents water from exiting the container. To function, the top of the sample chamber must be below the surface of the water table during sampling activities.

4.4.4.2 Geoprobe® Groundwater Sampling Systems

Geoprobe® offers three main systems to collect groundwater samples, Screen Point Groundwater Sampling Systems, Groundwater Profiler, and the MIP.

4.4.4.3 Screen Point 15/Groundwater Sampling System

The Screen Point Sampling systems are utilized for collection of groundwater samples within unlithified materials from just below ground surface to 100-feet bgs under applicable lithology conditions.

DPT advances a stain-less steel rod with a protected stainless steel or PVC screen used to collect discrete interval groundwater samples from the probe interior with a bailer, bladder pump, etc. Screen length may vary from a few inches to 41-inches. A grout plug, present at the base of the screen, enabling bottom-up bentonite grout placement for borehole abandonment as sampling equipment is removed. Disposable screens designed to be left in the borehole are available to reduce decontamination and disposal costs.

4.4.4.4 Groundwater Profiler

The Geoprobe® Groundwater Profiler enables groundwater vertical profiling, particularly in sand and gravel aquifers. Geophysical logs or soil sampling should be completed prior to use to evaluate borehole lithology to minimize clogging of the sample screen with fine-grained materials.

Groundwater samples are collected from discrete intervals with 6- to 12-inch long, 0.004-inch slotted screens, as the DPT probe is advance. Probe removal is not required between sample intervals, and development of the screen interval may be performed prior to sample collection to reduce turbidity. The probe may also be utilized for hydraulic conductivity testing at each sample interval.

4.4.4.5 Membrane Interface Probe (MIP)

The MIP is a semi-quantitative field analytical probe that measures total VOCs in groundwater with a semi-permeable membrane of a thin film polymer impregnated into a stainless steel screen for support. The membrane is heated to approximately 100 to 120 °C to accelerate diffusion of possible contaminate through the membrane, which are transported to the surface with a carrier gas (typically nitrogen or helium). Travel time from the membrane interface to the detector(s) is approximately 30 to 45 seconds (depending on the length of the sample line and flow rate).

FAMs typically utilized to analyze the MIP gas include photoionization detectors, flame ionization detectors, electron capture detectors, and ion-trap mass spectrometers. The presence of NAPL may require dilution of the gas stream, reducing the number of samples analyzed per day.

4.4.4.6 Drive-Point Profiler®

The Solinst® Drive-Point Profiler® is designed to collect samples from multiple discrete groundwater samples in a single DPT drilling location. The profiler is a modified version of the Waterloo Profiler® and consists of a 1.75-inch stainless steel probe with one row of screened inlet holes that are connected to a stainless steel, low-density polyethylene (LDPE), or Teflon® sampling tube that is attached to a surface pump (e.g., peristaltic pump). VOC samples are collected in-line through a Solinst VOA Bottle Filler, which is placed before the peristaltic pump heads to minimize loss of volatiles. The profiler collects samples and seals boreholes in a similar manner to the Geoprobe® systems described above.

4.4.4.7 BAT® GMS Sampling

The BAT® Groundwater Monitoring System (BAT) utilized with DPT offers temporary or permanent interconnection between BAT Piezometers for pore pressure and groundwater level measurement and vertical profiling, BAT Groundwater Sampler for discrete groundwater samples, collection of discrete soil gas samples, and BAT Permeameter for in-situ soil permeability measurement. Multiple discrete groundwater samples may be collected during a single DPT push and sampling does not require pumps. However, the probe does not provide direct or indirect stratigraphy interpretation and sampling time requirements may be excessive, if large sample volume is required.

The top of the probe sample housing is sealed with a flexible septum. The stainless steel tip is used to drive the probe to a desired sampling depth. At the designated sampling depth, the body of the probe is retracted to expose a stainless steel screen through which groundwater enters. The interior of the probe contains a sample vial (35 to 500 ml) with a septum cap. A double-ended needle, lowered through the push rod, penetrates the probe housing septum and the vial septum, permitting water to enter the sample vial. When the vial is full, the needle is removed and the vial is retrieved for storage or analysis.

The BAT® groundwater sample collection system also offers a probe tip constructed of porous high-density polyethylene (HDPE), which enables water to enter the probe when placed under a vacuum. The HDPE filter tip has the advantage of low turbidity over the standard stainless screen sampling system.

4.4.5 Monitoring Wells

4.4.5.1 Well Placement

Monitoring well networks may be constructed to evaluate:

- Groundwater flow (horizontally and vertically);
- Upgradient groundwater quality (on- and/or off-Site);
- Magnitude of MGP-related constituent concentrations in areas of release;
- Extent of MGP-related constituent concentrations down and side-gradient of release areas to define the extent of concentrations that exceed regulatory standards;
- Vertical extent of MGP-related constituent concentrations that exceed regulatory standards;
- Characterization of the nature and extent of NAPL (LNAPL or DNAPL); and
- Aquifer characteristics (e.g., hydraulic conductivity).

Evaluation for monitoring well network construction will also include evaluation of municipal, residential, and industrial wells within at least ¼-mile of the extent of constituent concentrations that exceed regulatory standards.

4.4.5.2 Well Screen Placement

Nested monitoring wells constructed to evaluate vertical extent and vertical flow may be constructed within 5-feet of each other horizontally. Nested monitoring wells in the same borehole may be considered on a site-specific basis if nested well locations are limited by underground utilities, access issues, or other site-specific conditions. If field conditions do not permit a 5-foot or less separation, the well separation will be expanded to 10-feet and field conditions requiring the expanded separation will be documented. Wells will not be considered nested if there are more than 10-feet separating them horizontally. To maintain well integrity, nested well construction within the same borehole will be performed only when justified by site-specific conditions, as discussed in SSWPs.

Water table monitoring well screens may be constructed in 5-, 10-, or 15-foot sections, dependent on field conditions. Typical water table monitoring well screens will be 10 feet in length. Site conditions that may require alternate screen lengths include: 1) a shorter well screens (5 feet) may be chosen to avoid penetration of a confining unit; 2) a longer well screen (15 feet) may be chosen when significant fluctuations are anticipate (e.g., adjacent to a dam). Piezometer screens will not exceed 5-feet in length.

Vertical placement of nested well screens will have a minimum 10-foot separation between the top and bottom of each filter pack, to reduce overlap between monitoring elevations. Variations due to field conditions (e.g., borehole refusal) will be documented.

4.4.5.3 Temporary Monitoring Wells

Temporary monitoring wells will generally not be used. Temporary monitoring well construction will be provided in SSWPs, if appropriate.

4.4.5.4 Small-Diameter Prepacked Monitoring Wells

Permanent small diameter prepacked monitoring wells may be constructed in DPT boreholes in accordance with ASTM D6725, Standard Practice for Direct Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers. SSWPs will provide specification data for the chosen manufacture(s) of prepacked monitoring wells. Material specifications for two manufactures with products that meet or exceed ASTM procedures (GeoInsight® (http://www.geoinsightonline.com/) and

Geoprobe® (http://www.geoprobe.com/index.htm)) were utilized for generalized discussion within this FSP.

The prepacked screens consist of a slotted schedule 40 and 80 PVC well screen pipe wrapped in stainless steel mesh. Sand is packed between the slotted PVC and the stainless steel mesh and screens typically are available in 1.4- and 2.5-inch outside diameter (OD) sizes. The well assembly is lowered to the base of the DPT probe rod string with threaded PVC riser pipe. The probe rod string is retracted above the well screen. Some systems are constructed with prepacked expanding annular space seal material. Systems that are not manufactured with a prepacked annular space seal are sealed with a filter pack seal (fine sand), placed directly above the well screen, preventing annual space seal grout from entering the screen. Granular bentonite or bentonite slurry is then placed above the fine sand as an annular space seal and surface seal. Small-diameter surface protection (stick-up and flush-mount) and well caps will be installed as well protection.

Small-diameter prepacked monitoring wells offer the following benefits over standard 2-inch diameter (or larger) monitoring well construction:

- Rapid and consistent well construction and installation;
- Minimal soil and water investigative waste generated for reduced disposal costs;
- Well seal and grouting meet USEPA and ASTM D5092 procedures;
- Minimal disturbance of natural formation;
- Ultra-fine sand filter packs are available that could not be consistently installed with traditional well construction techniques. The fine sand filter pack lowers turbidity and retards or eliminates well siltation in fine-grained material lithology; and
- Reduced development and sampling time requirements.

4.4.5.5 Large-Diameter Monitoring Wells

4.4.5.5.1 Well Borehole

Boreholes utilized for the construction of permanent large-diameter monitoring wells (2-inch OD or greater) will be drilled with 4-¼-inch inside diameter (ID) or larger HSAs or 6-inch ID or larger air or mud rotary or sonic borehole in accordance with SOP SAS-05-03. Drilling method(s) will be identified in Site-Specific Work Plans or FSPs. Continuous or five-foot interval soil samples may be collected with a 2-foot split-spoon sampler from ground surface to the base of each borehole in accordance with ASTM D4700 and D1586, with the exception of sonic boreholes, which yield a continuous core. Soil samples will be field identified utilizing USCS in accordance with ASTM D2488 and recorded on soil boring log information forms. Field visual and olfactory observations will also be noted on the boring logs.

4.4.5.5.2 Large-Diameter Monitoring Well Construction

Wells will be constructed in accordance with ASTM D5092, the SSWP, and SOP SAS-05-03 and will typically consist of a 2-inch OD PVC riser with a 0.01-inch factory constructed well screen. Water table monitoring wells will typically be constructed with a 10-foot well screen and piezometers with a 5-foot well screen or as determined on a site-specific basis.

Typically, filter-pack sand will be extended from 0.5-feet below the screen base to 2-feet above the screen top. A fine sand filter-pack seal will then be placed to 2-feet above the filter-pack sand. The annular space will be sealed with chipped bentonite, granular bentonite (shallow wells only), or bentonite grout. If grout is used, an additional filter-pack seal consisting of 2-feet of bentonite pellets will be placed above the fine sand filter-pack seal before placement of the grout. The well surface seal will consist of 5-feet of chipped bentonite with the well casing and a locking protective cover extending at least 2-feet above the final surface grade. If a flush-mount well protective cover is utilized, the well PVC will be terminated approximately 2- to 6-inches bgs and covered with a watertight cap. The protective cover will be one-foot aluminum or iron cover set in a concrete pad that extends at least 2-feet in diameter around the protective cover, which will be slightly raised in the center and sloped to the sides to allow positive drainage, away from the well. One to two inches of fine-grained sand may be placed at the base of the

flush-mounted protective cover to facilitate drainage or weep holes may be drilled into the protective cover. A locking expandable well cap will be placed on the top of the well casing to prevent surface water infiltration into the water column. Monitoring well construction forms will be completed and submitted with the subsequent reporting phase.

4.4.6 Monitoring Well Development

Monitoring wells will be developed and details will be recorded in general accordance with USEPA Monitoring Well Development Guidelines for Superfund Project Managers (1992), ASTM D5521, the SSWP, and SOP SAS-05-04 requirements (i.e., in field notes and on the monitoring well development forms). Wells will be developed using decontaminated or dedicated sampling equipment to reduce the possibility of cross contamination. The primary method for well development is a pump. Bailers may be used for development for low yielding wells or wells with a significant amount of sediment (approximately 10% in the well screen) to remove excess sediment. Purge water collected during well development will be treated by a mobile remediation system prior to discharge to a sanitary sewer or containerized as per the SSWP.

In general, monitoring wells that cannot be purged dry will be developed by alternating surging and purging the water column for at least 30-minutes and approximately 10 well volumes have been removed. If the drilling methods introduce water to the aquifer, three times the volume of water lost during drilling will be purged from the well prior to well development. Purge water volume may be reduced by completing development activity when purge water has no visible turbidity and field measurements have stabilized for specific conductance, pH, temperature, dissolved oxygen, ORP, and turbidity. Field measured parameters will be measured using a flow-through cell, if a pump is used for sampling. If bailers are used for sampling, representative purge water will be transferred to a disposable plastic cup or stainless steel cup and the water quality probe will be inserted or a down-hole meter will be used to measure field parameters. Stabilization is achieved when three consecutive readings spaced approximately 2 to 10 minutes, or 0.5 well volumes or more apart, are within the following ranges for the following indicator parameters:

Field Parameter	Stabilization Criterion[1]
Specific Conductance	± 3% (µS/cm @ 25°C)
pH	±0.1 pH units
Temperature	±0.1 ºC
Dissolved Oxygen	±0.3 mg/L
Eh or ORP	± 10 mV
Turbidity	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs and/or visually clear water

Surging activity will not be performed on monitoring wells that can be purged dry. The primary focus for development of monitoring wells constructed in fine-grained material is to limit the agitation of the water column, as this may form a "skin" around the exterior surface of the well, by which fine-grained sediment accumulates at the screen inlets and consolidates to form a low conductivity barrier. Additionally, the water column should be kept fairly stable during development, to ensure air is not introduced into the adjacent aquifer material.

Low hydraulic conductivity wells will generally be developed utilizing low-purge rate techniques with peristaltic/bladder pumps or dedicated/disposable bailers (if pumps are not feasible). Purging will alternate between pumping or bailing and a rest period, allowing the well to recover to within 90% of the pre-development standing water volume. Development will continue until the purge water is no longer turbid, with a minimum of two and a maximum of five purge periods.

[1] 2002, USEPA, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers; EPA 542-S-02-001, May.

Monitoring well development data will be recorded in field logbooks and/or on the appropriated field form in accordance with the SSWP and SOP SAS-05-04. Monitoring well development forms are included in Appendix B.

4.4.7 Monitoring Well Groundwater Sampling

Water level data will be collected from monitoring wells prior to sampling activities, as described in Section 4.4.3. Samples may be collected with low-flow sampling techniques in accordance with USEPA and ASTM guidelines or with dedicated bailers, based on site-specific conditions, as specified in SSWPs in accordance with SOPs SAS-08-01, SAS-08-02, and SAS-08-03. Water level measurements and well sampling will generally be conducted from least to most contaminated wells to limit the possibility of cross-contamination. Well integrity will be evaluated in accordance with SOP SAS-08-05 prior to collection of field data. Compromised monitoring wells may not be sampled and the scope deviation will be immediately discussed with the project manager for further well evaluation and repair or abandonment.

4.4.7.1 Purging

Wells will be purged with dedicated or decontaminated bailers or pumps. Bailers will be used if samples cannot be collected with a pump due to low yielding wells. Field measurements for specific conductance, pH, temperature, ORP, dissolved oxygen, and turbidity will be taken at the time of sample collection. Field measured parameters will be measured using a flow-through cell, if a pump is used for sampling. If bailers are used for sampling, representative purge water will be transferred to a container and the water quality probe will be inserted or a down-hole meter will be used to measure field parameters. The procedures for measuring groundwater field parameters, operating the equipment and a comprehensive list of sampling equipment needed to collect groundwater samples is provided in the SSWP and SOPs SAS-08-02 and SAS-08-03. Purging for low-flow sampling wells may be conducted as described below for low-flow sampling wells. Wells purged with bailers will be purged in accordance with USEPA requirements and ASTM recommendations and will generally follow the procedures listed below. Purge techniques will be chosen SSWPs.

- Volume Purge: Field readings, summarized below, will be collected prior to and following well purging activities. At least 4-well volumes will be removed from the well casing in a manner that limits agitation of the water column with bailers or pumps. Field readings will be recorded

in field logbooks and/or on the appropriate field form. Purge volumes may be established on a site-specific basis when monitored natural attenuation parameters are not required and sufficient data exists to determine an appropriate purge volume.

- Stabilization Purge: Field measured parameters, listed below, will be monitored during purge activity. Stabilized parameters indicate the completion of the purging phase. At least three consecutive readings spaced approximately 2 minutes, or 0.5 well volumes or more apart, are within the following ranges for the following indicator parameters:

Field Parameter	Stabilization Criterion[1]
Specific Conductance	± 3% µS/cm @ 25°C
pH	±0.1 pH units
Temperature	±0.1 ºC
Dissolved Oxygen	±0.3 mg/L
Eh or ORP	± 10 mV
Turbidity	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs and/or visually clear water

4.4.7.2 Sample Collection

Samples will be placed in appropriate laboratory supplied containers and preserved in accordance with the example analytical requirements for methods listed in Table 1. Samples will be collected in order of analyte stability, as summarized below.

- VOCs/PVOCs;
- PAHs;

[1] 2002, USEPA, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA 542-S-02-001, May.

- Non-filtered, non-preserved samples (total metals, sulfate, PCBs, etc.);
- Non-filtered, preserved samples (phenols, nitrogen, phosphorous, cyanide, TOC, total metals, etc.);
- Filtered, non-preserved;
- Filtered, preserved immediately (dissolved metals); and
- Miscellaneous parameters.

QC samples will be collected consecutively to ensure appropriate duplicate sample collection. An example of bottle filling order is summarized below.

- Well A - VOC containers filled;
- Well A Duplicate Sample - VOC containers filled;
- Well A - PAH container filled;
- Well A Duplicate Sample - PAH container filled;
- Well A - Cyanide container filled; and
- Well A Duplicate Sample - Cyanide container filled.

Groundwater samples will be placed in appropriate laboratory supplied containers and preserved in accordance with the analytical requirements summarized in Table 1. Procedures for collecting groundwater samples are described in the SSWP and SOPs SAS-08-02 and SAS-08-03. Samples submitted for dissolved analytes will be field filtered prior to placement in containers. Procedures for field filtering are described in the SSWP and SOPs SAS-08-02.

4.4.7.2.1 Bailer Sampling

Bailers may be used to collect samples in low yielding wells. Bailers, dedicated or disposable, will be raised and lowered in a manner that limits agitation of the water column. Bailers will not be allowed to touch the base of the well to limit suspension of fine particles. Sampling equipment, including bailer rope, will not be allowed to touch the ground surface. Water will be decanted from the bailer and into sample containers with a bottom-emptying device to limit sample volatilization.

4.4.7.2.2 Low-Flow Sampling

Low flow sampling is synonymous with low-stress sampling; this should be kept in mind by persons conducting low-flow sampling. The purpose of low-flow sampling is to collect a representative formation sample. This is accomplished through use of low discharge pump rates equilibrated with groundwater infiltration into the well, usually between 100 and 500 mL/min. Higher rates are possible in highly permeable formations. Low flow conditions have not been reached until the following conditions have been met:

- The water level within the well has stabilized during pumping;
- The water being removed is within the screen interval; and
- The measurements of water quality indicators have stabilized.

Refer to SOP SAS-08-02 to determine if low flow sampling is the appropriate method of sample collection for a specific well.

The following equipment is required to perform low-flow sampling:

- Pump capable of withdrawal at a constant rate between 100 and 500 mL/min that can meet the designed lift requirements (e.g., peristaltic pump and/or bladder pump). Peristaltic pumps may be used when the well depth is less than or equal to fifteen feet, in zones of high contamination, or as approved in a SSWP. The sampling method may be modified to demonstrate attainment of cleanup goals in the future;
- In-line flow cell equipped with a multiprobe such as the QED-MP20;
- All necessary tubing required to reach the screened interval of the well and connect the pump to the flow cell;
- A flow meter or other type of water measuring device to accurately measure and monitor the discharge from the pumping well;
- Electric water level indicator(s) capable of measurement to the hundredth of a foot;
- A 5-gallon pail to collect purge water; and
- Low flow sampling field forms (Appendix B), pens, and field book.

Prior to sample collection, any equipment that comes into contact with the water should be decontaminated in accordance with the SSWP and SOP SAS-04-04. The cleaned equipment should not come into contact with the ground or any other surface that may impart contaminants. The sampling tube is lowered to an elevation near the center of the screen, a minimum of 1-foot above the well sump to the extent practical. Subsequent sampling should be performed at approximately the same elevation. The pumping rate will be determined by field staff based on:

- Start the pump at 100 mL/min or the lowest rate possible;
- Monitor drawdown, which must not exceed 0.1 meters or 0.3 feet (SOP SAS-08-02);
- Slowly increase the pumping rate and monitor drawdown;
- If drawdown is rapid decrease the pumping rate;
- If drawdown continues at the lowest pumping rate, cease pumping and evaluate the use of bailer sampling or diffusion samplers with the project manager; and
- If there is no drawdown, the pumping rate may be increased slowly until drawdown occurs and stabilizes.

During drawdown and through sample collection, water quality is continually monitored and recorded by a water quality probe in a flow-through cell (e.g., QED MP-20). Measurements will be recorded at a rate equivalent to the time required to fill the flow-through cell volume. Therefore, if the volume of the flow through cell is 500 mL/min and the pumping rate is 250 mL/min; one reading should be taken every 2 minutes. Stabilization is achieved when three consecutive readings have fallen within the rages of the parameters in the table below.

Field Parameter	Stabilization Criterion[1]
Specific Conductance	± 3% µS/cm @ 25°C

[1] 2002, USEPA, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA 542-S-02-001, May.

Field Parameter	Stabilization Criterion[1]
pH	±0.1 pH units
Temperature	±0.1 ºC
Dissolved Oxygen	±0.3 mg/L
Eh or ORP	± 10 mV
Turbidity	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs and/or visually clear water

Prior to sample collection, the flow-through cell will be disconnected and laboratory containers will be filled from the system tubing. The flow rate will not be adjusted following parameter stabilization or during sample collection.

4.4.7.2.3 Diffusion Sampling

Diffusion samplers and related sampling technologies will not typically be utilized for sample collection. Diffusion sampling will be considered for monitoring wells with extremely low hydraulic conductivity that cannot readily be purged without removing the entire water column and/or requires multiple field visits for purging and sample collection.

The diffusion sampler is considered a passive sampling device and consists of a semi-permeable polyethylene diffusion bag (PDB), a stainless-steel hanger, and a stainless-steel weight. The PDB is filled with deionized water, lowered into the well, and left in place adjacent to the well screen. Potential contaminants in the groundwater diffuse into the sampler until the concentration gradient equilibrates between the formation and PDB water. The sampler is retrieved and the PDB contents are considered the well sample. Additional diffusion sampling information will be provided in SSWPs if the sampling technique is proposed.

4.4.8 Potable Wells

As part of the CSM development, potable well construction information will be obtained, if it exists. Water levels will generally not be collected from potable wells. If water levels are collected from potable wells, sampling equipment must be decontaminated and disinfected prior to data collection SOP SAS-04-04). Disinfection procedures will be included in SSWPs if potable well water readings will be collected. Sampling of large water supply wells (e.g., public water utilities) is not generally conducted and specifics for these types of sample collection will be included in SSWPs.

Small water supply well samples will be collected from the tap that is closest to the well pump as practical (SOP SAS-08-06). Preferably, the faucet should be in the water supply line after the wellhead and before pressure tanks, water heaters, water softeners, iron filters, etc. Aerators and filters will be removed from the tap prior to sampling. Water will be discharged at the faucet or a nearby sink for at least two minutes after the pump is activated. The time period after pump activation should allow for at least one full pump cycle and to ensure formation water is sampled. Field data (e.g., sampling locations, discharge volume, and time) will be recorded in field logbooks.

If a sample is collected from a faucet after the pressure tank or other appliances, the water discharged prior to sample collection should be two to three times the volume of water in each appliance. Sample collection variations will be recorded in field logbooks.

4.4.9 Aquifer Characterization

Aquifer characterization will include collection of grain-size distribution samples, hydraulic conductivity testing, constant-rate pumping tests, etc. Aquifer characteristic measured by or estimated from these tests include transmissivity (T), hydraulic conductivity (K), specific yield (Sy) for unconfined aquifers, storage coefficient (S) for confined aquifers, effective porosity, flow velocity, etc. Formations of high hydraulic conductivity represent areas of greater groundwater flow; therefore, zones of potential preferred contaminant migration. Further, anisotropy within strata or formations affects the magnitude and direction of groundwater flow. Thus, information on aquifer characterization is necessary to evaluate preferential flow paths and groundwater velocity.

Hydrogeologic assessments should contain data on the hydraulic conductivities of significant formations as measured in monitoring wells. It may be beneficial to use numerical or laboratory methods to augment results of field tests. However, field methods provide the best definition of the horizontal hydraulic conductivity in most cases. Field methods differ from laboratory methods which measure vertical hydraulic conductivity, typically in Shelby tube samples.

Varieties of procedures are available for evaluating hydraulic conductivity in the field. ASTM D4043 Standard Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques will be consulted in selecting an appropriate test method. Field methods for collecting hydraulic conductivity data are described in a number of ASTM standard practices and detailed in (SOP SAS-08-04). Additional methods, such as high density samplers and direct sensing tools, will be evaluated on a site site-specific basis, as appropriate, and included in SSWPs as applicable.

4.4.9.1 Single Well Tests

Hydraulic conductivity can be determined in the field using a variety of test methods, each addressing specific conditions, and/or data collection objectives. These methods are commonly referred to as bail down or slug tests and are performed by removing a slug (known volume) of water from a well and observing the recovery of the water surface to its original level. Similar results can be achieved by removing a cylindrical "slug" of inert solid material, pressurizing the well casing, depressing the water level, and suddenly releasing the pressure to simulate removal of water from the well. Hydraulic conductivity can be determined in monitoring wells with well screens below the water table using the falling head test. The falling head tests are performed by adding a known volume of water or inserting a cylindrical "slug" of inert solid into the well and observing the recovery of the water surface to its original level.

Observation wells in which the well screen intersects the water table (e.g., water table wells) will be tested only by methods involving the use of a solid slug or removal of water from the well in order to minimize the potential for well screen filter pack interference. Addition of water to a monitor well is appropriate only to piezometer installation. However, the addition of water to any monitoring well shall be avoided whenever possible, since the addition may affect water quality in sampling events. In cases

where addition of water to a well is unavoidable, it should be of documentable known quality and 3 times the volume of water added should be removed upon completion of the test.

It is important that bail-down or falling head tests be of sufficient duration to provide representative measures of hydraulic conductivity. Data from the tests shall be analyzed entered into a computerized format such as Aqtesolv® or equivalent software. The appropriate method (e.g., Bouwer and Rice [1976], etc.) to analyze single well tests is dependent on the characteristics of the response (i.e., oscillatory, etc.) observed.

4.4.9.2 Pneumatic Slug Test Kit

Geoprobe® offers the pneumatic slug test kit for use with small-diameter monitoring wells. Pneumatic slug testing includes sealing the wellhead and applying air pressure to displace (lower) the water column until the pressure exerted by the water and air are equal, at the point the water level stabilizes. A release valve is then quickly opened, instantaneously releasing the air pressure. The water level recovers, providing a rising head slug test. A pressure transducer and data logger are utilized to record the changes in water level and time.

4.4.9.3 Multiple Well Tests

Multiple well tests, more commonly referred to as pumping tests, are performed by pumping water from one well and observing the resulting drawdown in nearby wells. Tests conducted with wells screened in the same water-bearing formation provide hydraulic conductivity data. Tests conducted with wells screened in different water-bearing zones furnish information concerning hydraulic communication between units. Multiple well tests for hydraulic conductivity are advantageous because they characterize a greater proportion of the subsurface and thus provide a greater amount of detail. Multiple well tests are subject to similar constraints to those listed above for single well tests. Some additional problems that should have been considered in conducting a multiple well test include: (1) storage of potentially contaminated water pumped from the well system, and (2) potential effects of groundwater pumping on existing waste plumes. The geologic constraints should be considered to interpret the pumping test results. Incorrect assumptions regarding geology may translate into incorrect estimations of hydraulic conductivity.

4.4.9.4 Controlled Pumping Tests

The most representative method for determining aquifer characteristics is by controlled aquifer pumping tests, because these tests stress a much larger volume of the formation than slug tests and laboratory tests. Pumping tests require a higher level of effort and expense and are not always required to achieve CSM goals. As an example, slug tests may be acceptable for hydrogeologic characterization, whereas pumping tests may be performed to support remedial design or modeling.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required dependent on field conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report. Detailed information for controlled pumping tests will be provided with appropriate SSWPs.

4.4.10 Monitoring Well Abandonment

Monitoring wells will be abandoned in accordance with the SSWP and SOP SAS-05-05. The well casing will be completely filled with bentonite chips, grout, or granules. If the well casing is removed during abandonment, the bentonite seal will be placed as the casing is removed. The well protective cover and surface seal material will then be removed and the well casing cut off at least 30 inches bgs. The annular space shall be filled with bentonite chips, grout, or granules to at least 30 inches bgs unless land use requires a design modification to use ,native material (gravel, soil, etc.) or material in adjacent areas (asphalt, concrete, etc.) to bring the former well location to grade. These modifications will be addressed in the SSWP. Monitoring well abandonment will be documented in accordance with the SSWP and SOP SAS-01-01. The appropriate state, and/or local borehole abandonment form(s) must also be completed to document abandonment activities.

4.5 Groundwater / Surface Water Dynamic Evaluation

This section summarizes data collection methods for evaluation the groundwater / surface water interface (GW/SW) at Sites with upland and water body areas. These methods are intended to evaluate the migration of contaminants into groundwater from contaminated sediments (losing stream) and/or surface water or into sediment from contaminated groundwater (gaining stream) or surface water. GW/SW

evaluations will be conducted to support risk evaluation (consistent with the CSM and RAF or SSWP) and delineation of extent as part of the remedial investigation. Applicable DQOs from the QAPP and SOPs SAS-04-01 and SAS-04-02 will be identified and considered for interface assessment and sampling, as applicable, to ensure satisfactory SSWP sampling methodologies. This may be especially significant when the extent of upland and/or sediment contamination is present at or near the interface. SSWPs will identify specific sampling methods for evaluation of the GW/SW based on data objectives and hydrology/geology characteristics.

4.5.1 Direct Pore Water Sampling

Direct pore water samples may be collected from the GW/SW interface for geochemical characteristics as well as contaminant concentrations. The field of collecting pore water samples is currently expanding quickly due to regulatory and private industry research in evaluating the GW/SW interface. Collection of field data for evaluation of the GW/SW interface can be performed with a variety of devices:

- Small-Diameter Piezometers

  Small-diameter nested temporary and/or permanent piezometers are clustered to provide hydraulic head differential and pore water samples for COPC concentration analysis (ITRC 2004). Piezometers are generally restricted to use in shallow water with relatively weak currents to the long-term integrity of the sample device. Pore water samples are collected from the piezometers with peristaltic, centrifugal, or bladder pumps. The primary advantages of piezometers are that they can be installed to depths of several feet by hand, and, if protected, they potentially allow repeated samples over time from a particular location and depth interval.

- Syringe Sampling

  Plastic and metal syringes, pushed into sediment, can be used to take collect pore water samples. Collection volumes are dependent on the syringe barrel volume and sample depth is dependent on needle length the bore ID. Pore water samples are obtained by pushing the needle to the desired depth and retracting the plunger. Syringes may not be effective in compacted sediments or gravels and can become plugged in very fine sediments (ITRC 2004). They are also depth limited.

- BAT Sampler

  The BAT system, as described in Section 4.4.4.7, may be deployed in sediments for collecting profile samples, which may be used to evaluate the GW/SW interface. The BAT system mat is driven by machine, or by hand if in soft sediments.

- Pushpoint Pore Water Tool

A pushpoint sampler is a needle-like, small-diameter tube with a "T" handle, which is pushed into sediment. Water and sediment are prevented from entering the tube during placement by a solid rod that is inserted into the tube. The rod is pulled upward once the sampler has been driven to the desired sample depth. Maximum sample depth is 6-feet, and this device has been proven effective for sampling porewater from submerged sediments. Peristaltic pumps or syringes are utilized to collect water samples from the sampler (MHE 2001 and ITRC 2007).

- Seepage Meters

  There is a significant body of work in the literature describing seepage meters. While originally designed as an inexpensive approach to measure the flux of groundwater seepage into or out of a water body, high-tech versions are now available for porewater sampling. The advantages of these devices are their ability to measure groundwater flux and obtain pore water samples in deep water.

4.5.2 Indirect Pore Water Samplers

Indirect samplers provide sample analysis of contaminants through diffusion and dialysis. The sampler is buried in the sediment, or is placed in a tube inserted in the sediment, and retrieved days, weeks, or months later, depending on the time needed to achieve equilibrium (USEPA, 2001). These samplers are the focus of ongoing research to determine their compatibility with different chemical constituents and substrates. A list of devices is provided below, and a summary can be obtained at http://clu-in.org/programs/21m2/sediment/.

- Diffusion Sampler
- Dialysis Sampler
- Peeper Sampler
- Diffusion Equilibration in Thin Films
- Vapor Diffusion Samplers
- Semi-permeable Membrane Samplers

4.5.3 Pore Water Sampling Summary

The pushpoint porewater sampler offers significant advantages over the other approaches in that it is a proven technology, can be used to measure hydraulic head in the sediment, can be used to collect as large

of a porewater sample as the sediment can yield, is minimally invasive, can be used under water, and is economical. Its limitations are that it is limited to depths of 6-feet, is difficult to use in deep water, and it may be difficult to push or extract water in tight, low-permeability clays. However, other sampling devices described here can be used in these situations.

4.6 Surface Water Monitoring

4.6.1 Surface Water Sampling

The former MGP properties are adjacent to rivers in which MGP residuals have been detected in either sediments and/or surface water, based on sampling that has been conducted in previous studies. River water samples may be collected for analysis of chemical parameters to evaluate their magnitude as well as the mass of COPCs discharged from the river. Surface water sampling requirements will be identified in the SSWPs.

In general, site, upstream, and downstream sample results are compared to evaluate whether concentrations of COPCs increase as water flows through the Site. Sample locations relative to flow will be identified in SSWPs. An example of the analytical methods, detection limits, required sample volumes, holding times, and preservatives for each of these parameters are summarized on Table 1.

Surface water sampling will follow procedures outlined in the SSWP and SOP SAS-09-01. Water samples will be collected using a discrete depth sampler such as a Kemmerer or Van Dorn-type sample bottle or using a pump. Sample depths will be established in the SSWP (e.g., mid-water or 0.2 and 0.8 times the total depth) depending on site-specific conditions (e.g., total water depth) and DQOs. At the time of sample collection field measurements of temperature, conductivity, pH, ORP, and dissolved oxygen will also be made at all locations.

4.6.1.1 Ecological Risk Assessment Samples

Surface water samples may be collected on a transect extending from the shoreline to the opposite shoreline or beyond the area of impacted sediment under base flow conditions, to the extent practical. Reference transects may also be sampled. Samples may be collected under various river flow conditions,

including high-energy events that may result in sediment re-suspension. Collected samples may be split with one fraction filtered (0.45 µm filter) in the field. Both the filtered (if collected) and unfiltered fractions will may be analyzed for COPCs determined by the SSWP. Samples will be filtered in accordance with procedures for groundwater sample filtration described in SOP SAS-08-02.

4.6.1.2 Human Health Risk Assessment Samples

Surface water samples may be collected along the shoreline adjacent to the former MGP property or on a transect extending from the shoreline to the opposite shoreline, and at reference locations in water two to three feet deep under base flow conditions, to the extent practical. Samples may be collected under various river flow conditions. Unfiltered samples will be analyzed for COPCs determined by the SSWP.

4.6.2 River Hydrology

Measurements of river discharge will be obtained from river gauging data available through the US Geological Survey and/or the appropriate state-specific agency. These data generally include information on base, average and flood flow discharges that may be used to assess COPC mass movement. These data may also be used to evaluate conditions where sediments become re-suspended and for related engineering parameters for remedial alternative analysis. SOP SAS-09-02 describes procedures for measuring streamflow, at sites where a gaging station is not located nearby. Other pertinent information will be as described in the SSWP.

4.7 Sediment Sampling

4.7.1 Overview

This section describes sediment sample requirements and collection methods. Sediment sampling will be conducted to support a risk evaluation (consistent with the CSM) and identify areas to be considered in the Study Applicable DQOs from the QAPP and SOPs SAS-04-01 and SAS-04-02 will be identified and considered for sediment sampling requirements on a site-specific basis to ensure chosen sampling methodologies satisfy DQOs. This is especially significant when the extent of sediment contamination is to be defined.

Sediment sampling techniques will be chosen and details discussed within the framework of each SSWP. Factors considered for selecting sediment-sampling techniques include existing data (e.g., distribution of known contaminants, sediment thicknesses, sediment type, water depth, and access) and specifications for risk evaluation. Sampling option speed, cost, and accessibilities will also be evaluated during sampling technique selection. Sampling activity details will be recorded in field logbooks and boring logs as described in the QAPP Section 1.7, the SSWPs, and SOPs SAS-01-01, SAS-07-02, and SAS-07-03.

4.7.2 Sediment Sampling Locations

The results of all previous sediment sampling will be used to focus initial Study sampling activities, including candidate stations to be sampled. Initial locations will be chosen prior to mobilizing the Study sampling effort. It is the intent of the dynamic sampling approach to allow for incorporating real-time information to drive flexibility with sample numbers and locations. Site-specific sampling locations will be detailed in the SSWP.

In general, sediment samples will be collected as discrete samples (for field or fixed-laboratory analysis). Some of these discrete samples will be composited if a large sample volume is needed (e.g., sediment toxicity testing). Specificity on discrete and composite sample analysis procedures and determination will be provided in SSWPs. Required sample volumes will be detailed in the SSWP. Samples that will be analyzed by a fixed-based laboratory will be shipped under COCs in accordance with the SSWP and SOPs SAS-03-01 and SAS-03-02. Sampling apparatus will be decontaminated in accordance with the SSWP and SOP SAS-04-04.

4.7.3 Sediment Data Uses

Sediment data will be collected to support screening level ecological risk assessment and baseline ecological risk assessment, human health risk assessment, delineation of the extent of contamination, sediment stability, and waste characterization. The sediment sampling approach will be presented in the SSWPs. Sediment sample analysis will also be identified in the SSWPs and may include PAHs (alkylated and parent), PVOCs, phenols, metals, cyanide, total organic carbon, black carbon content, percent solids, and grain-size distribution.

4.7.3.1 Screening Level Ecological Risk Assessment (SLERA) and Baseline Ecological Risk Assessment (BERA)

The RAF or SSWP describes the approach to assessing ecological risk. Sediment samples collected to assess the exposure to ecological receptors are typically limited to the surficial six inches of sediment (the biologically active zone). Sample locations will also be identified in the SSWPs.

4.7.3.2 Bioavailability Samples

Sediment samples may be analyzed for soot-phase black carbon (soot) in a fixed laboratory for use in bioavailability assessments as described in the RAF or SSWP. Microscopic inspection of the larger particle sizes to evaluate the amount of coal particles or coal dust in the sample may also performed. Special handling techniques are not required for samples to be analyzed for soot carbon.

The determination of soot is based upon the method of Accardi-Dey and Gschwend (2003). Microscopic inspection of samples using reflected light organic petrology methods (Stach 1982) also will be conducted and reflectance of organic particles (soot, lampblack, and coal) will be quantitatively measured for source identification purposes.

While analyses for total metals can be collected throughout the sediment column, samples for acid volatile sulfides-simultaneously extracted metals (AVS-SEM) analysis will be collected from the upper 2.0 cm of sediment, in accordance with USEPA recommendations (USEPA 2005). Further, USEPA recommends that AVS-SEM samples be collected between November and May, when formation of AVS compounds is generally lowest due to specific environmental conditions that occur during this portion of the year (USEPA, 2005). These samples will be collected using grab or coring methods to limit oxidation during sample retrieval. Coring is the preferred sample collection method because there is generally less disturbance of the sediment, various horizons of the sediment may be collected and analyzed, and the sample can be retrieved with less possibility of oxidation, especially if PVC liners are used.

4.7.3.3 Benthic Community Investigation

A benthic community investigation may be performed as discussed in the SSWPs. Benthic community samples of the surface sediments (0 to 6 inches) will be collected from the sample locations to be

discussed in the SSWP and refined based on analytical results. Benthic community samples may be collected concurrently with other samples or during a separate sampling event after comparison of chemical results to screening values. Benthic community sampling and laboratory analysis procedures will be described in detail in SSWPs. As described in the SSWP, the quality of the aquatic environment will be evaluated using methods adopted from USEPA's Rapid Bioassessment Protocol (RBP) (USEPA, 1999). The benthic community investigation design will consider the following factors:

- Substrate type;
- Water velocity;
- Water depth; and
- Analytical results and distribution of COPCs.

The results from the sites will be qualitatively compared to the results from the areas ambient conditions. Establishing the locations of ambient conditions is discussed in the RAF or SSWP and will also be discussed in the SSWP to include site-specific conditions. The following benthic community structure attributes may be evaluated:

- Total taxa richness;
- Total chironomid richness;
- Total density;
- Chironomid density;
- Oligochaete density; and
- Relative species abundance.

4.7.3.4 Sediment Toxicity Testing

A 28-day Hyalella azteca toxicity test may be conducted as part of the modified SLERA approach discussed in the RAF or SSWPs. Each set of whole sediment toxicity tests will be conducted with uncontaminated control sediment and a minimum of 8 replicates of each sediment sample with a survival and growth endpoint. The procedure is described in EPA/600/R-99/064 Methods for Measuring the

Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates, Second Edition; Method 100.4.

4.7.3.5 Human Health Risk Assessment

Sediment samples will be collected for a human health risk assessment. Soft sediment samples will be collected adjacent to and slightly downstream of the former MGP property, generally within the areas previously investigated and in areas where there is a higher probability of direct contact to MGP residuals in the sediments due to recreational activities (e.g., wading, swimming, fishing, etc). The absolute elevation, depth to the top of soft sediment, and the thickness of soft sediment will be recorded on field logs in accordance with the SSWP and SOP SAS-07-01. Human health risk assessment sediment location selection criteria will be identified in SSWP. Samples will be collected with devices and processed as described in Section 4.7.7 below. Sediment samples may be analyzed in a field or fixed-based laboratory. The samples will be sent to a fixed-base laboratory under COC procedures and may be analyzed for the COPCs identified in the CSM and RAF or SSWP.

4.7.4 Delineation Sediment Sampling

Sediment coring will be conducted to further characterize sediment concentrations and the nature of soft sediment. The soft sediment samples will be collected using a coring device and processed as described in the SSWP and SOP SAS-07-03. Each soft sediment sample will be analyzed in a field or fixed-based laboratory to further characterize sediment concentrations of the COPCs identified in the SSWP. The number of samples to be collected to meet the DQOs will be discussed in SSWPs. Cores which exhibit visible evidence of tar or significant sheen in all intervals may not be analyzed because these visual observations may be used to establish areas for which remedial alternatives will be developed. Cores without visual evidence of tar or significant sheen will be analyzed for COPCs (identified in the CSM and RAF or SSWP) to characterize concentrations in sediment. The analytical data packages will be fully validated by a person independent of the laboratory producing the data.

4.7.5 Sediment Stability and Contaminant Fate and Transport

The remedial investigations will include an appropriate assessment of sediment stability and contaminant fate and transport. The goal is to determine the likelihood that buried contaminants will stay buried or be exposed due to both natural and man-made (anthropogenic) forces. This will be an important factor in the feasibility study for appropriate remedies such as monitored natural recovery, removal by excavation or dredging, or in-situ containment by capping.

The former MGP Sites are considered relatively "small" in scale and "simple" in complexity, versus "large" and "complex" sediment sites. Therefore, appropriate empirical methods in lieu of computer models are planned to be used to assess the extent of past sediment and contaminant movement. A list of key empirical methods is provided in Table 6 (USEPA 2005). The SSWPs will describe the methods to be used on a Site-specific basis.

4.7.6 Geotechnical and Waste Characterization Sampling

At approximately 20 percent of the core locations for delineation, a co-located core may be collected for testing of geotechnical parameters for use in the Study. These parameters include Atterberg limits, grain size, specific gravity, organic content by loss-on-ignition, and moisture content. Field measurements to estimate shear strength may be collected using a pocket penetrometer and a torvane (using a large vane for soft soils). Geotechnical samples may be discrete intervals, or composite samples, depending on the conditions observed.

A composite sample will also be prepared for waste characterization by collecting and combining the entire co-located core from 3 different locations in the project area. The number of cores/locations required may be adjusted based on site-specific field encountered conditions. These locations will be chosen to represent the impacted site area(s) as required by the SSWP for use in the FS. The cores will be composited as described in SOP SAS-06-01. The composite sample will be sent to a fixed-base laboratory following COC procedures. The sample will be analyzed for typical disposal parameters (e.g., reactivity, corrosivity, etc.) to identify potential disposal options and manage investigative waste.

Disposal and/or dredging of river sediments may be regulated by local, state, and federal agencies (refer to Section 9.1). Research will be conducted on a site-specific basis to determine which regulations and appropriate permits apply. Research may include, but not be limited to, contacting local zoning offices, evaluating state regulations, and contacting the US Army Corps of Engineers for permit requirements.

4.7.7 Sediment Collection Devices and Methods

This section describes sediment collection devices used to collect sediments of different thicknesses. Sample processing steps are also included. All details regarding sample collection will be recorded in the field logbook. Procedures for sediment sampling are described in the SSWP and SOP SAS-07-03. Analyses required for preliminary sediment samples will be provided in SSWPs.

4.7.7.1 Surficial Sediment Collection and Processing

A Ponar™ grab sampler (or equivalent) will be used to collect surficial sediment samples (defined as the 0 to 6 inch interval of sediments). The depth to the top of soft sediment and the thickness of soft sediment measured by poling techniques will be recorded prior to using the Ponar™ grab sampler.

The Ponar™ grab is a self-closing sampler which uses a spring loaded "pinch-pin" that releases when the lowering line becomes slack. The grab sampler can be used for taking samples from hard bottoms (sand, clay) as well as soft sediment deposits. This type of sampler is used for collecting surficial (top six inches) sediment samples which can be used for delineating extent of contamination in surficial sediment, assessing benthic community structure, and for collecting larger sample volumes that are needed for toxicity testing.

The grab sampler will be manually lowered into the water to the top of sediment at which time the sample device will shut and the sampler will be manually raised to the boat deck. The sample will be analyzed for the presence of volatile organic vapors with a PID, inspected for acceptance criteria (e.g., grab sampler penetrated at least four-inches, was not overfilled, and was completely closed when brought to the surface), standing water will be removed, and the sediment will be described according to ASTM D2488, as referenced in SAS-07-02. Visual observations of affected sediment will be recorded using the descriptions from SAS-05-02, Attachment E. The sediment will be removed from the grab

sampler. If VOCs/PVOCs are to be analyzed a discrete sample will be collected. The remaining sample will be homogenized in a stainless steel bowl using a stainless steel spoon. Sufficient sediment volume will be collected (as described in the QAPP) and mixed in the bowl to allow for chemical analysis (mobile laboratory and fixed-base laboratory, in select samples), physical analysis, and sediment toxicity testing. The grab sampler will then be decontaminated following SOP SAS-04-04. Horizontal control will utilize global positioning system (GPS) and the boat will be properly anchored to maintain position. Complete procedures for the collection of sediment samples using a grab sampler are outlined in the SSWP and SOP SAS-07-03. Sediment will be classified consistent with SOP SAS-07-02.

4.7.7.2 Coring Devices

Two types of coring devices may be used to collect core samples. A hand or push corer may be used to collect short cores (e.g., 0 to 2 feet bgs) and a Vibracore™ sampler may be used to collect core samples from the SSWP identified sediment column depth(s).

4.7.7.3 Hand or Push Core Sampling and Processing

For sediment samples up to four feet below the sediment/surface water interface, an Ogeechee™ open barrel corer or other drive-push sampler will be manually pushed or driven to collect undisturbed sediment samples in water depths ranging from 0.5 to 10 m.

The corer is deployed from the sampling vessel by hand and is manned by two crewmembers: one field personnel handles the deployment and retrieval of the core, while the other field personnel operates the vessel and records the sampling information. Following retrieval of the corer, the sample will be extruded from the core sleeve, analyzed for the presence of volatile organic vapors with a PID, and the sediment will be described in accordance with ASTM D2488. Non-representative material (e.g., stones, wood chips) will be removed from the sample at the discretion of the field sampler and will be documented in the field log. Sufficient sediment volume will be collected (as described in the QAPP) and mixed in the bowl to allow for chemical analysis which may include the COPCs identified in the CSM and SSWP. Procedures for the collection of sediment samples using a core sampler are outlined in the SSWP and SOP SAS-07-03.

4.7.7.4 Vibracore Sampling and Processing

A Vibracore sampler or equivalent may be used to sample sediments to refusal (e.g., top of consolidated sediment). The Vibracore sampler is electrically powered to advance a core tube up to 20 feet into soft sediment. Previously obtained data has shown that core recoveries are as low as 60 percent; however, technology for collecting core samples has advanced to the point where 90 percent recovery is common for most sample types. To prevent precluding any emergent technologies, a performance-based specification will be written in the request for proposal to potential sampling subcontractors. The specifications that will be required include:

- Ability to attain and maintain station position: use of spuds is preferred over anchoring;
- Station location: less than 3 feet (approximately 1 m) (x, y) using GPS in latitude/longitude degrees, minutes, and seconds;
- Depth measurement with water level correction: less than 0.1 feet (approximately 3 cm) (z) referenced to vertical control system specified in the SSWP; water elevation to be surveyed at least once per day (e.g., mid-day) for determining core sample elevation;
- Coring equipment: Vibracore or equivalent;
- Recovery/penetration: greater than 80 percent (this is a goal, not a minimum requirement);
- Ability to document rate of penetration; and
- Ability to collect core samples down to the native clay layer (potentially 5 to 20 feet).

As cores are brought to the surface, the sediment will be analyzed for the presence of volatile organic vapors with a PID and described in accordance with the ASTM D2488. Each core will be subdivided into 1-foot intervals. The bottom interval will be combined with the interval above it if it is less than 6 inches long. If greater than 6 inches, the bottom interval will be its own sample. Each 1-foot interval will be homogenized in a stainless steel bowl using a stainless steel spoon. Non-representative material (e.g., stones, wood chips) will be removed from the sample at the discretion of the field sampler and will be documented in the field log. Sufficient sediment volume will be collected (as described in the QAPP) and mixed in the bowl to allow for chemical analysis which may include the COPCs identified in the CSM and SSWP. Complete procedures for the collection of sediment samples using a Vibracore are described in SSWP and SOP SAS-07-03.

4.7.7.5 Support Sediment Sampling Equipment

In addition to the sediment sampling devices additional equipment needed to collect sediment samples including a boat, GPS unit, sample containers, and appropriate PPE as required by the HASP. The SSWP and SOP SAS-07-03 provide a comprehensive list of sampling equipment.

4.7.8 In-Situ Field Screening Methods

A variety of probing devices are available that provide real-time qualitative to semi-qualitative subsurface data. The in-situ field screening methods are rapidly developing and changing; therefore, SSWPs will evaluate the current state of the practice for in-situ field screening on a Site-specific basis. SOPs will be developed, as needed, in the event these technologies are deemed appropriate and suitable for the SSWPs. Several screening methods will be evaluated for use in sediment screening on a Site-specific basis and these are described below:

4.7.8.1 LIF Screening Methods

LIF probes that will be evaluated include the Rapid Optical Screening Tool (ROST™) and the Tar-specific Green Optical Screening Tool (TarGOST®), which is a specialized version of the UltraViolet Optical Screening Tool (UVOST™). These tools are operated in the field by the vendor to identify the presence or absence of tars. Examples of current industry field operating standards are provided as Appendix C. If selected, the vendors SOP will be provided in the SSWP or prior to initiating field activities.

TarGOST® detection limits are currently less than or equal to 500 ppm, when calibrated to site-specific conditions, which will be useful in locating and delineating the presence of tar in sediment. ROST™ detection limits vary from 50 to 1,000 ppm, depending on sample matrix and contaminant characteristics. Potential limitations of LIF probes include interference induced by naturally occurring organic matter and probe difficulties with advancing through hard surfaces. These potential limitations will be evaluated on a Site-specific basis.

LIF precision is estimated by evaluating multiple calibration samples, analyzed before and after each push. LIF accuracy is evaluated qualitatively by assessing the agreement between LIF probe detection and non-detection and corresponding laboratory confirmation samples. The false negative rate for the ROST probe ranges from 3.3 to 10 percent, depending on the confirmatory method used[1].

4.7.8.2 DART Method

In sediment areas where LIF probe deployment is not technically or economically feasible, the DART system[2] may be evaluated to screen sediments for PAHs. The DART sampler is a continuous rod coated with a solid-phase extraction (SPE) media that sorb PAH constituents. Rods are manually deployed, with typical depths achieved ranging from 1 to 20 feet. PAHs sorb to the rod from sediment particles, pore water, or NAPL in sediment pores. The rods are typically deployed for 24 hours (may be longer) to allow sufficient time for the concentration gradient between PAHs in the sediment matrix and pores and the SPE to equilibrate. Following equilibration, the rods are removed and shipped for laboratory analysis by LIF.

4.7.9 Sediment Poling

Poling is used to determine soft sediment thickness. Data collected from poling is used to supplement and field verify hydrographic surveys results, and to collect additional data for specific sampling locations. The pole is a 2-inch diameter, aluminum pole and consists of several six-foot long aluminum sections that can be placed together to the appropriate length, and is marked in one-foot increments which in turn are subdivided into one-inch increments. The pole is deployed by hand from the sampling vessel manned by two crewmembers; one field personnel handles the deployment and retrieval of the pole, while the other field personnel operates the vessel and records the sampling information.

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[1] USEPA, November 22, 2006, Technology Innovation Program Website, *Laser-Induced Fluorescence Web Page*, http://www.clu-in.org/char/technologies/lif.cfm.

[2] Dakota Technologies, February 2007, http://www.dakotatechnologies.com/?content=templates/news_detail.tpl&id=97.

Essentially, the pole is slowly lowered into the water column until there is slight resistance, at which point the pole is read to the nearest inch mark and the result recorded in accordance with the SSWP and Field SOP(s). This is the depth to sediment from the water surface. The pole is the pushed until refusal occurs, at which point the pole is read again to the nearest inch mark and the reading recorded in the field logbook and/or on the appropriate field form. That is the depth to refusal measurement. The pole is then slowly retrieved from the sediment. All observations (potential sediment type encountered, olfactory evidence of contamination) will be recorded. Horizontal control will utilize GPS and the boat will be properly anchored to maintain position. Sediment poling will follow the procedures outlined in the SSWP and SOP SAS-07-01.

4.8 Soil Vapor Assessment

4.8.1 Overview

This section describes the soil vapor sampling collection method. Soil vapor sampling may be completed to support risk evaluations (consistent with the CSM and RAF or SSWP). Soil vapor sampling locations may be selected based both existing and planned building locations, if necessary, to evaluate possible vapor migration pathways. Applicable DQOs from the QAPP will be identified and considered when soil vapor sampling is required, so that the resulting data will satisfy the DQOs. SSWPs will be developed with inclusions of emerging regulatory and industry accepted procedures, including USEPA (draft vapor intrusion guidance (USEPA 2002)), Interstate Technology & Regulatory Council (ITRC) guidance on assessment of the vapor intrusion pathway (ITRC 2007), and pending ASTM guidance on vapor intrusion assessment. If necessary, sites will be screened for potential vapor assessment requirements utilizing groundwater and soil concentration data in accordance with USEPA and ITRC guidelines.

4.8.2 Data Uses

Soil vapor samples may be collected to evaluate vapor migration pathways and entry routes in the vicinity of the former MGP facilities, if applicable to assess Human Health Risk. Air sample collection will include the installation of small-diameter vapor monitoring wells and subsequent soil vapor air sample collection. Soil vapor investigations will be conducted in accordance with the SSWP, SOPs SAS-11-01

and SAS-11-02 and the OSWER 2002 *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*.

4.8.3 Soil Vapor Methodology and Analysis

Soil vapor samples will be collected from small-diameter soil vapor wells installed in the upper 10-feet of subsurface material, or shallower. Site-specific DQOs will be considered when evaluating the appropriate sample depth, as presented in SSWPs. These samples will provide data used to evaluate potential vapor migration. Vapor monitoring wells will be installed with DPT. Soil vapor monitoring wells will be constructed in the same manner as small-diameter groundwater monitoring wells described in Section 4.4.5.4.

Soil vapor samples will be analyzed for VOCs by USEPA Method TO15A. Samples will be collected in evacuated summa canisters provided by the laboratory, and shipped via overnight courier to the laboratory. Grab samples will be collected from the vapor wells, the canisters will be filled in less than one minute. Air samples will be collected in accordance with SOPs included in SSWPs. A minimum of two rounds of soil vapor samples will be collected prior to analysis of the soil vapor analytical results, so that the presence or absence of vapors can be confirmed.

Additional procedures related soil vapor sampling and measurement procedures will be addressed in the SSWP, if relevant and are presented in SOPs SAS-11-03, SAS-11-04, SAS-11-05, and SAS-11-06, which all pertain to monitoring and measuring soil vapor extraction (SVE) system effectiveness and field screening for fixed gases and soil vapor concentrations.

4.9 Field Documentation

4.9.1.1 Field Data Recording

Field activities will be documented in accordance with the SSWP, QAPP Section 1.7, and SOP SAS-01-01. Data generated in the field will be reduced and validated in the field, as appropriate, and before reporting as described in QAPP Section 4. SSWPs will provide data flow charts detailing Site-specific document review, document control, data visualization, data flow management charts and communication

lines and time frames to implement the dynamic work plan. A Generic Sample Data Management Flow Diagram is presented as Figure 4.

4.9.1.2 Data Tracking, Storage, and Retrieval

Field data forms and sheets will be tracked and stored electronically in the project file and retrieved as described in the SSWP and SOP SAS-01-02.

4.9.1.3 Final Evidence Files

All final data, field notes, and other pertinent documents produced or delivered will be tracked and stored as required by the SOP SAS-01-02.

5 SAMPLE HANDLING

Sampling handling and chain of custody requirements are described the SSWP and SOPs SAS-03-01 and SAS-03-02. Laboratory custody, handling, and tracking procedures are discussed in the QAPP Section 2.

5.1.1 Sample Identification

Laboratory and field analytical samples will be assigned a unique sample number in accordance with the SSWP, SOP SAS-03-01, and as described in the QAPP Section 2.3.

5.1.2 Sample Container, Volume, Preservation and Holding Times

Sampled media (soil, water, sediment, air, and waste) will be containerized, preserved, and stored in accordance with the SSWP and SOP SAS-03-01. An example of general sample containers, volumes, preservatives, and holding times for soil, water, and sediment samples are summarized on Table 1. Prior to initiating Study activities, the analytical laboratories will verify sample container, volume, preservation, and holding times.

5.1.3 Field Sampling Quality Control

Field quality control samples will be collected as described in QAPP Section 2.5, the SSWPs, and SOP SAS-04-03.

5.1.4 Sample Custody

Chain of custody procedures will be conducted in accordance with the SSWP and SOP SAS-03-02 and as described in QAPP Section 2.3.2.

5.1.5 Sample Shipping

Transportation and shipping requirements are detailed in the SSWP, SOP SAS-03-01, and QAPP Section 2.3.

6 SAMPLE ANALYSIS

6.1.1 Previous Sampling and Analysis

The COPCs presented in the Generalized CSM are based on the results of previous sampling and analysis activities at the Sites. A summary of previous analytical methods utilized for soil, sediment, water, and air is provided as Table 7.

In general, soil and groundwater samples were collected from several former MGP properties between the late 1980s and the present. Soil samples were previously collected as discrete samples from test pits, remedial excavations, soil borings, and surface soil grabs. On occasion, soil samples were composited for physical and/or chemical tests needed for remedial option analysis. Groundwater samples were previously collected with standard dedicated bailers for each well. Bailers have been removed from monitoring wells that are currently sampled utilizing low-flow sampling techniques. A few HydroPunch® and borehole grab samples were collected and analyzed for benzene, toluene, ethylbenzene, and total xylenes (BTEX), PAH, and occasionally cyanide.

As summarized on Table 7, initial soil and groundwater samples were typically analyzed for VOCs/PVOCs, base/neutrals or PAHs, metals, cyanide, and various inorganics parameters (e.g., ammonia, nitrogen, and sulfate). Constituents that were not detected after repeated sampling rounds were not carried forward in subsequent sampling events. The need to analyze for additional constituents, beyond the COPCs provided in the Generalized CSM, will be evaluated on a site-by-site basis as part of developing the SSWPs.

6.1.2 Chemical Analysis

COPCs are discussed in the Generalized CSM Section 4.1 and include:

- PVOCs;
- (parent and alkylated) PAHs;
- Select phenols;
- Cyanide compounds; and

- Metals.

Additional COPCs may be evaluated on a site-by-site basis. Geochemical analysis may be performed to assess the remedial alternative and trend analysis. These parameters may include:

- Alkalinity;
- Chloride;
- Total Dissolved Solids;
- Total Organic Carbon;
- Nitrate; and
- Sulfate.

Analytical parameters and Project Quantitation Limits (PQLs) for media of concern are summarized on Tables 8 and 9. SSWPs will present site-specific PQLs, as appropriate. Analytical methods will be selected based on data needs, quality objectives, regulatory requirements and acceptance, cost, optimization of real-time decision-making and Site-specific conditions. A site-specific Sampling and Analysis Plan Summary will be provided within the SSWP. An example is provided in Table 1.

6.1.3 Field Based Analytical Method Selection Criteria

FAMs will be initially screened for evaluation in accordance with the QAPP and Laboratory Quality Assurance Manuals (QAM). FAMs will be identified with field sampling techniques to ensure representative samples of known quality are collected to achieve project goals. A Generic Method Selection Process is presented as Figure 3. Utilizing project goals and field conditions, and how the technology or strategy performs, field analytical methods will be evaluated for selection based on the following:

- Sensitivity (detection and quantitation limits);
- Selectivity (detection or quantification of single or class analytes);
- Dynamic Range (detection range without dilution);

- Analytical Turn Around Time;
- Precision and Accuracy (method bias may be manageable within project goals);
- Indirect Measurement;
- Field Condition Constraints (accessibility, size, utility requirements), and
- Analysis Derived Waste (safety, cost, and disposal issues).

These selection criteria will be used to determine if the selected method(s) are capable of quantifying analytes in a timely and cost-efficient manner. SSWP will detail the sensitivity, selectivity, dynamic range, and how well the technology or strategy performs for selected field methods to support project decisions. SSWP will also detail QA/QC procedures, samples, and schedule, in accordance with the QAPP and QAM, which will be utilized to ensure the quality of field generated data. FAMs that may be used, but are not limited to the options listed below.

- LIF;
- MIP;
- Ion-Specific Electrode (conventional and In-Situ; SW-846 9200);
- X-ray Fluorescence (SW-846 6200);
- Immunoassay (SW-846 4000);
- Colorimetric (SW-846 8500 and 9000);
- Gas Chromatograph (SW-846 8000);
- Mass Spectrometer (SW-846 8265); and
- Electrochemical Methods (SW-846 7472 and 9078).

Indirect FAMs that may be used, but are not limited to, the options listed below.

- CPT;
- GeoVIS®; and
- Fiber-Optic Sensors.

SOPs for these field analytical methods will be developed as they may be incorporated into sampling and analysis strategies on a Site-specific basis.

6.1.4 Geotechnical Testing

Samples will be collected in accordance with SSWP requirements and may be tested for grain size distribution, moisture content, specific capacity, strength, hydraulic conductivity testing, aquifer pump test, etc. General precision and field units are presented on Tables 8 and 9. Site-specific tests and associated precision and measurement requirements will be presented in SSWPs.

7 FIELD SURVEYING

7.1.1 Overview

Base maps exist or shall be prepared for each of the former MGP properties covered by this FSP. In general, features included on the survey include property boundaries and topographic survey, staff gauge locations, soil sampling locations, sediment-sampling locations, and existing and abandoned groundwater monitoring well locations. If appropriate, field surveying will be performed as necessary to update the project mapping. Field surveying will be used to locate sampling locations, assess the lateral and vertical extent of affected areas, and evaluate the interaction of surface water and groundwater.

7.1.2 Horizontal and Vertical Control

The location of sample points will be determined with horizontal control as described in the SSWP and SOP SAS-03-03. Elevation measurements will be based on the system specified in the SSWP and SOP SAS-02-02. This coordinate system will be used for establishing horizontal and vertical control to sampling data. On a site-specific basis, additional survey control may be utilized and SOPs will be provided in SSWPs.

7.1.3 Data Acquisition

A minimum of two control points will be established at the Site upon which the SSWP-specific coordinates and elevation are set. These points will be established in a permanent location where they will not be disturbed.

Measured elevations will be tied to existing site control points, which will be referenced to elevations and horizontal locations using the vertical and horizontal controls specified in the SSWP. Horizontal orientation locations will be accurate to ±0.1 feet and vertical orientation elevations accurate to ±0.01 feet.

7.1.4 Previously Obtained Survey Data

A number of the MGP Sites have previously obtained sample locations that were surveyed based on an arbitrary coordinate system. The coordinate data associated with these previously obtained samples will be converted to agree with the coordinate system established for each individual Site in the SSWP.

8 DECONTAMINATION

8.1 Overview

Decontamination procedures will be performed to remove chemical constituents from sampling equipment used during Study activities. Proper decontamination procedures prevent chemical constituents from being transferred between sampling location and being transported out of controlled areas.

Decontamination procedures for Field Team Members are addressed in Section 9 of the HASP. Field Team Members will follow applicable safety procedures while performing equipment decontamination including, wearing safety glass and boots, and refraining from eating, smoking, or chewing gum.

8.2 Decontamination of Personnel

A decontamination area for sample preparation equipment will be established within or near the boundary of the Exclusion Zone (EZ). The EZ is defined as the area where contamination is either known or likely to be present, or because of activity, will potentially harm personnel. Entry into the EZ requires the use of personal protective equipment.

A personnel decontamination station will be established outside and adjacent to the EZ. All personnel will remove excess dirt from boots and clothing prior to leaving the decontamination area. If necessary, boots will be decontaminated similarly to sampling tools (Alconox and rinse water). All personnel will wash their hands prior to leaving the decontamination stations. Personal protective equipment will be left in the field activity area(s) during breaks after performing decontamination procedures.

Certain parts of respirators, such as the harness assembly and cloth components are difficult to decontaminate. If grossly contaminated, they will be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush. Individual owners of respirators are responsible for decontaminating and maintaining their own respirators.

8.3 Decontamination of Equipment

Cleaning and decontamination of all equipment shall occur at a designated field activity area, downgradient, and downwind from the clean equipment drying and storage areas. The cleaning and decontamination area will consist of a decontamination pad constructed out of wood and lined with plastic to contain the waste/rinse water until it is containerized and handled as investigative waste. Decontamination procedures will be performed and documented in accordance with the SSWP and SOP SAS-04-04.

8.3.1 Sampling Equipment

Sampling equipment requires special cleaning. Decontamination of all sampling equipment will be performed in accordance with the following procedure:

- Wash the equipment with a solution of Alconox and potable water. Additionally, circulate the solution through non-dedicated equipment, such as submersible pumps; and
- Triple rinse the equipment with distilled water, allow to air dry.

8.3.2 Tools

Tools used during sample preparation (e.g., mixing bowls, hand augers, split spoons, and spatulas) will be decontaminated in accordance with the following procedure:

- Remove all soil by scrubbing with a mixture of Alconox and potable water;
- Rinse with potable water; and
- Triple rinse with distilled water.

8.3.3 Heavy Equipment and Vehicles

Drill rigs and other heavy equipment are difficult to decontaminate. Generally, they are steam cleaned with water under high pressure and/or accessible parts are scrubbed with detergent/water solution under pressure, if possible. Particular care must be given to those components in direct contact with

contaminants, such as tires, augers, or buckets. Before leaving field activity areas, all heavy equipment and vehicles will be inspected by the Field Leader to confirm the decontamination effort.

8.3.4 Cleaning and Decontamination of Equipment/Sample Containers

8.3.4.1 Equipment Decontamination

As described in the QAPP Section 2.2.2, equipment decontamination procedures will be kept to a minimum through the use of either dedicated or disposable sampling equipment. However, some sampling equipment will require decontamination, and these include equipment made of glass, metals, Teflon™, and other plastic materials. Equipment decontamination procedures are described in the SSWP and SOP SAS-04-04.

8.3.4.2 Sample Container Decontamination

Sample container decontamination is not anticipated to be required, as the analytical laboratory will provide all containers for samples to be submitted for laboratory analysis. As described in the QAPP Section 2.2.2, sample containers will not be used if the container integrity is compromised in any manner.

9 MANAGEMENT OF INVESTIGATIVE DERIVED WASTES

IDW will be generated during the Study sampling activities. The methodology for the management, storage, and disposal of the wastes is described below. Each investigative waste stream will require specific handling, storage, and disposal procedures to ensure that potential adverse environmental impacts associated with the waste do not occur, and that all wastes are characterized ,transported, and disposed in accordance with the provisions set forth in the Off-Site Rule, Code of Federal of Regulations (40 CFR 300.400).

9.1 Investigative Waste Sources

Sources of investigative derived waste likely to be generated at the Sites include the following:

- Soil and/or sediment generated during the sampling and installation of test pits, soil borings, and monitoring wells;
- Groundwater IDW generated during monitoring well development, purging, and sampling activities;
- Decontamination wastes generated during decontamination of field equipment, sampling equipment, and personal protective equipment; and
- Personal protective equipment associated with worker health and safety.

9.2 Soil and/or Sediment

Soil and/or sediment generated during the advancement of drilling and similar activities (augers, hydraulic push, sonic) will be handled as a waste product. Drill cuttings will be accumulated at the drilling location in a manner that prevents erosion or direct contact exposure (e.g., 55-gallon drums, landfill roll-off boxes, tarped and bermed stockpiles, etc.). Drilling mud, if generated, will be solidified and classified as drill cuttings. Waste soil is occasional generated during test pit sampling that cannot be

replaced in the test pit. This soil and/or sediment will be disposed off-Site on a Site-specific basis based on field use and activity phase and in accordance with USEPA's Off-Site Rule (40 CFR 300.440).

Each container or stockpile will be labeled with the information necessary to identify source area(s) and dates of accumulation. Soil and/or sediment will be temporarily stored while waste characterization analysis is completed. Waste characterization will be performed and a waste profile will be established for these materials unless the waste is covered under an existing profile. Soils and/or sediment will be disposed of as a special solid waste at facilities previously used and/or approved by the Company and USEPA. In these cases, off-site disposal will be coordinated prior to or as soon as practical following the completion of field activities.

Soils and/or sediment generated that are different (either physically or contaminant source area) from historic drilling wastes may need to be profiled separately. A composite sample will be collected from the drums of drilling spoil and submitted for laboratory analysis. The permitted disposal facility will determine what analyses are required to complete the waste profile. Following waste characterization profile acceptance by a disposal facility, the soil and/or sediment will be transported by a certified waste hauler for off-site disposal.

9.3 Well Development and Purge Water

Purge water generated from well development and groundwater sample collection activities will be managed as a waste. The procedures for handling development/purge water will require the collection of this water at the monitoring well location in a bulk storage container. The bulk storage container should be inspected prior to use to assure it will not leak.

Development/purge water will then be treated in field activity area(s) through a portable granular activated carbon canister prior to discharge to a publicly owned treatment works (POTW) sanitary sewer system, or disposed of off-site in accordance with federal, state, and local regulations and the SSWP. Development/purge water containing NAPL will be filtered through a strainer and PIG® Oil-Only Pad. The strainer and pad will be placed in a sealed 55-gallon drum and co-disposed with soil in bulk containers as solid waste.

9.4 Decontamination Wastes

Wastes associated with the decontamination of field equipment will consist primarily of liquids, with minor amounts of solids. The wastes will be generated by the cleaning of:

- Soil boring and sampling equipment (e.g., drill rig/backhoe);
- Monitoring well development equipment; and
- Personnel exiting the exclusion zone around each sampling location.

Following generation, decontamination water will be placed in a bulk storage container. The decontamination water should be decanted during transfer to the bulk storage container as to minimize the amount of solids transferred. Solids present after decanting will be placed in drums and treated as soil investigative waste. Disposal of decanted decontamination water will be the same as for the disposal of development/purge water.

9.5 Personal Protective Equipment

Waste personal PPE generated during the field activities will be placed in a sealed 55-gallon drum and co-disposed with soil in bulk containers. Waste PPE that is free of NAPL will be stored in plastic garbage bags and disposed of in a dumpster with general refuse, unless otherwise specified in the SSWP.

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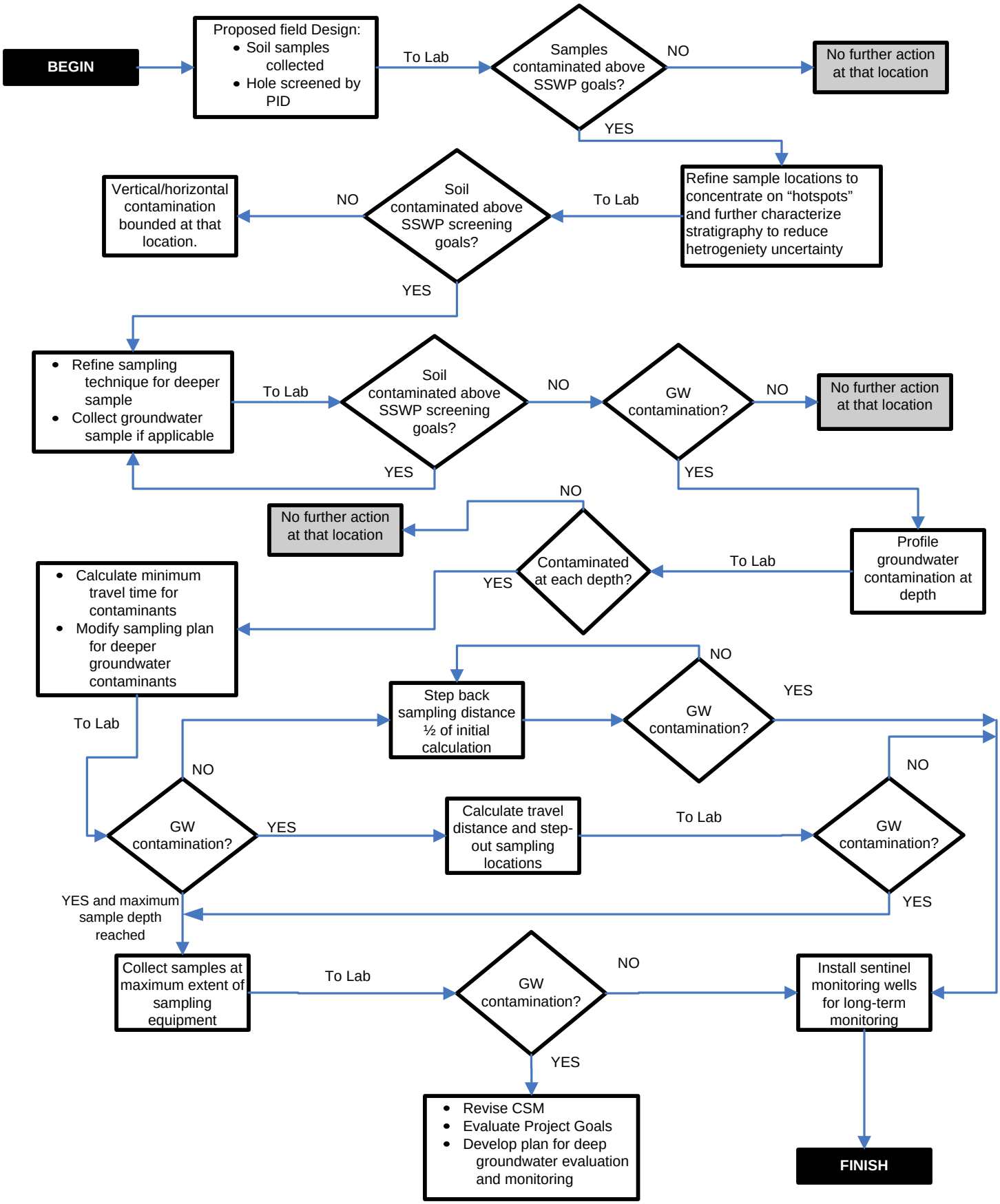
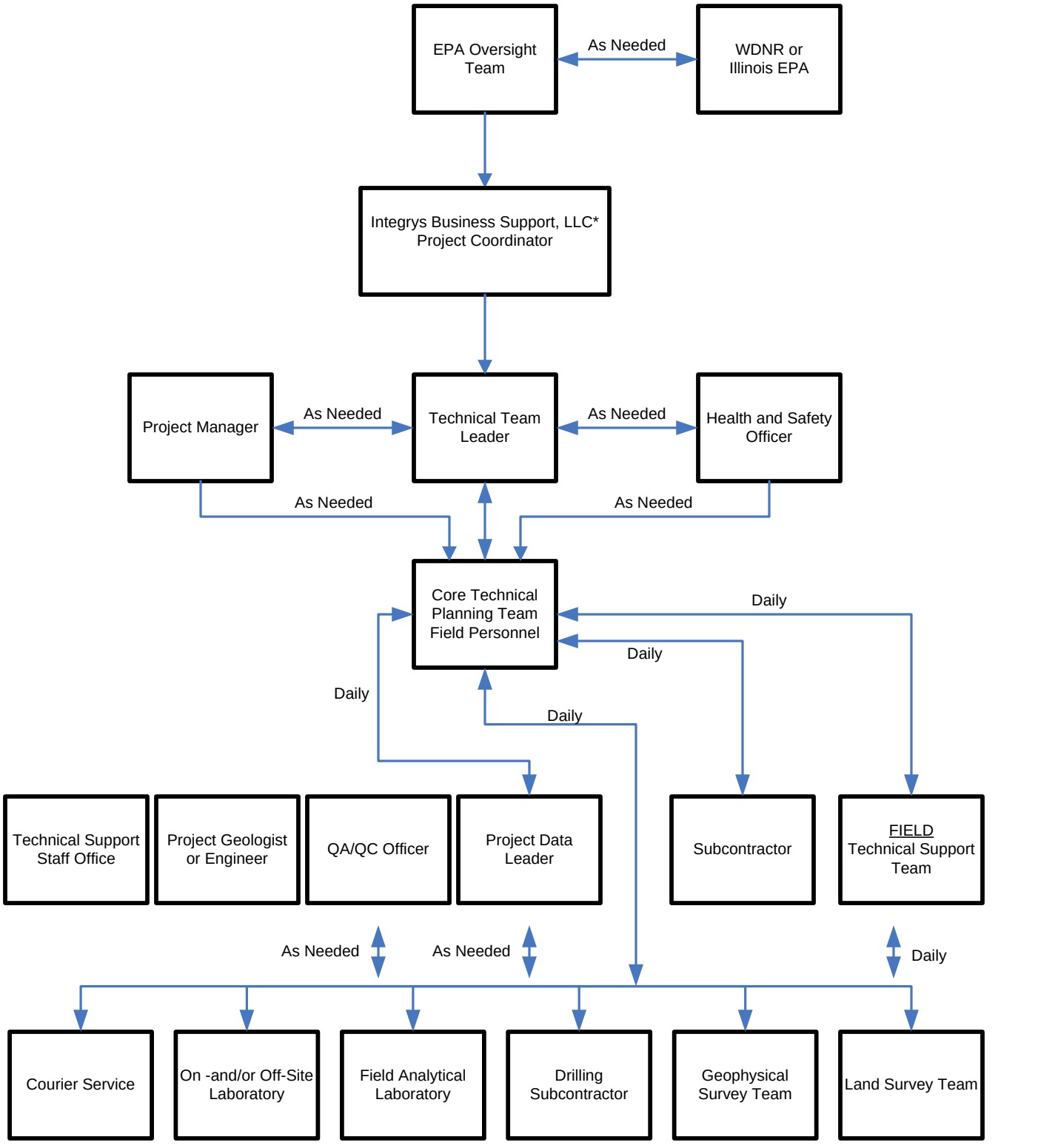
FIGURES

FIGURE 1 GENERIC REMEDIAL INVESTIGATION / ENGINEERING EVALUATION FIELD DATA DECISION TREE



Source: USEPA, 2003, Using Dynamic Field Activities for On-Site Decision Making, OSWER 9200.1-40

FIGURE 2 GENERIC TECHNICAL TEAM STRATEGY

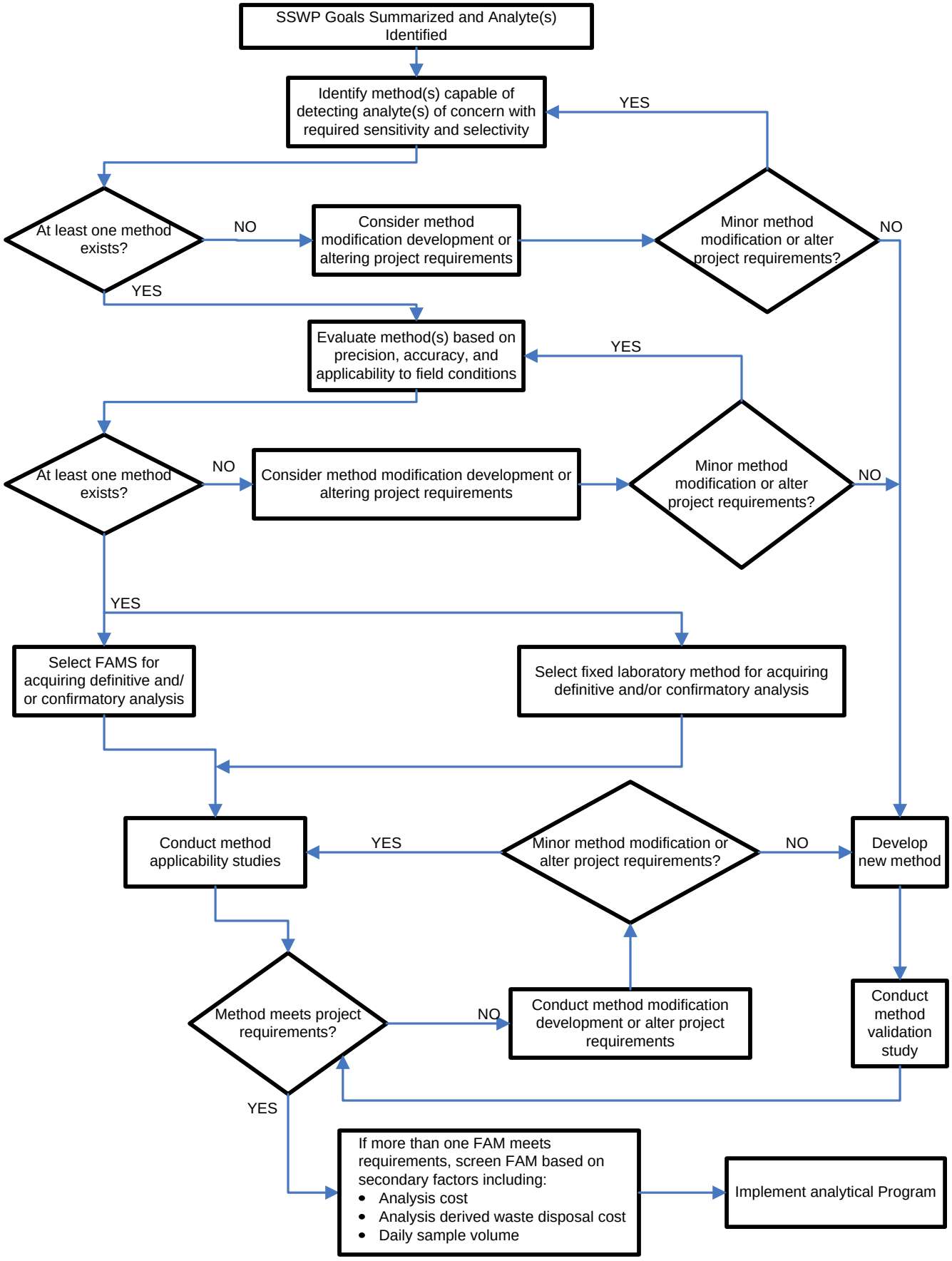


NOTE

* Study work performed for Wisconsin Public Service Corporation, The Peoples Gas Light And Coke Company, and North Shore Gas Company former MGP Sites is managed by Integrys Business Support, LLC.

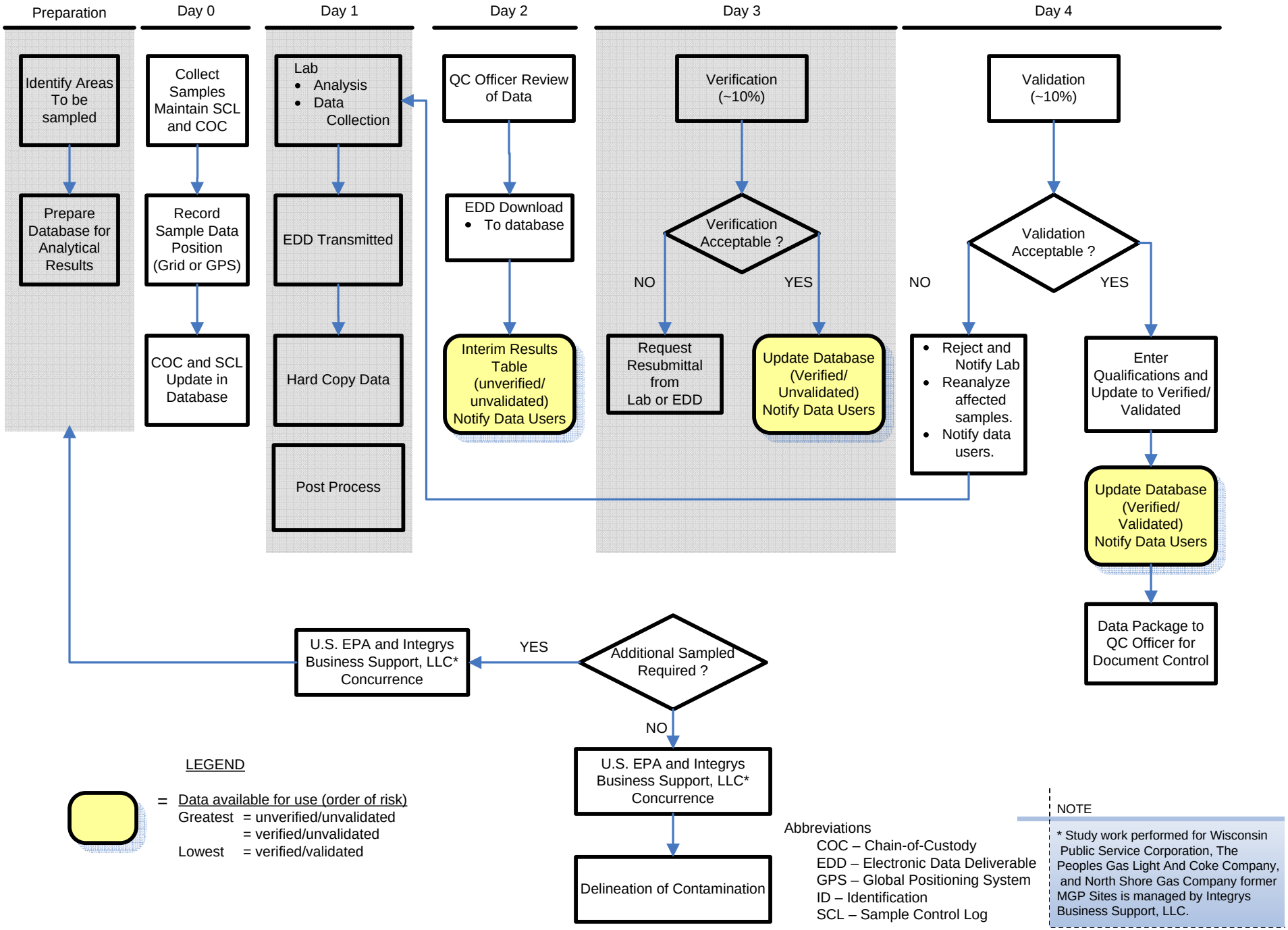
Source: USEPA, 2003, Using Dynamic Field Activities for On-Site Decision Making, OSWER 9200.1-40

FIGURE 3 GENERIC METHOD SELECTION PROCESS OVERVIEW



Source: USEPA, 2003, Using Dynamic Field Activities for On-Site Decision Making, OSWER 9200.1-40

FIGURE 4 GENERIC SAMPLING DATA MANAGEMENT FLOW DIAGRAM



Source: USEPA, 2003, Using Dynamic Field Activities for On-Site Decision Making, OSWER 9200.1-40

TABLES

Table 1. Multi-Site Field Sampling Plan Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Sample Type/Location[1]	Matrix	Parameter [2]	Method	Sample Quantity [3]	Field Duplicates [4]	Equipment Blanks [5]	MS/MSD[6]	TOTAL	Container Type	Minimum Volume	Preservation	Holding Time from Sample Date
Surface Soil for human health and terrestrial ecological risk assessments (0 to 2 feet bgs)	soil	PVOCs	SW846 8260B						glass	2 oz.	methanol, Cool to 4° ≥ 2°C	7/28 days
		PAHs	SW846 8270C GC/MS SIM						amber glass	2 liters	Cool to 4° ≥ 2°C	14 days
		Phenols	SW846 9066						amber glass	250 ml	Cool to 4° ≥ 2°C	28 days
		Cyanide	SW846 9012A						plastic	125 ml	Cool to 4° ≥ 2°C	14 days
		MGP Metals[7]	SW846 6020A SW846 7470A						plastic	600 ml	HNO_3 to pH<2 Cool to 4° ≥ 2°C	6 months
Sub-surface Soil for human health risk assessments (2 feet bgs to water table)	soil	PVOCs	SW846 8260B						glass	2 oz.	methanol, Cool to 4° ≥ 2°C	7/28 days
		PAHs	SW846 8270C GC/MS SIM						amber glass	2 liters	Cool to 4° ≥ 2°C	14 days
		Phenols	SW846 9066						amber glass	250 ml	Cool to 4° ≥ 2°C	28 days
		Cyanide	SW846 9012A						plastic	125 ml	Cool to 4° ≥ 2°C	14 days
		MGP Metals[7]	SW846 6020A, 7470A						plastic	600 ml	HNO_3 to pH<2 Cool to 4° ≥ 2°C	6 months
Groundwater for human health risk assessments	water	PVOCs	SW846 8260B						glass vial	2-40 ml	HCl to pH<2, Zero Headspace, Cool to 4° ≥ 2°C	14 days
		PAHs	SW846 8270C GC/MS SIM						amber glass	2 liters	Cool to 4° ≥ 2°C	14 days
		Phenols	SW846 9066						amber glass	1 liters	H_2SO_4 to pH<2 Cool to 4° ≥ 2°C	28 days
		Cyanide, total	SW846 9012A						plastic	500 ml	NaOH ≥ 12 Cool to 4° ≥ 2°C	14 days
		Cyanide, available	USEPA OIA 1677						amber glass	250 ml	NaOH ≥ 12 Cool to 4° ≥ 2°C $PbCO_3$ & filter if S^{-2} present $C_6H_8O_6$ if Cl, OCl^-, SO_3^{-2} present $C_2H_8N_2$ if soluble $O=CH^-$ present	14 days
		MGP Metals[7]	SW846 6020A, 7470A						plastic	600 ml	HNO_3 to pH<2 Cool to 4° ≥ 2°C	6 months
		Temperature	field instruments						field measured	n/a	n/a	immediate field measurement
		pH	field instruments						field measured	n/a	n/a	immediate field measurement
		Specific Conductivity	field instruments						field measured	n/a	n/a	immediate field measurement
		Oxidation-Reduction Potential	field instruments						field measured	n/a	n/a	immediate field measurement
		DO	field instruments						field measured	n/a	n/a	immediate field measurement
		Turbidity	field instruments						field measured	n/a	n/a	immediate field measurement

Table 1. Multi-Site Field Sampling Plan Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Sample Type/Location[1]	Matrix	Parameter [2]	Method	Sample Quantity [3]	Field Duplicates [4]	Equipment Blanks [5]	MS/MSD[6]	TOTAL	Container Type	Minimum Volume	Preservation	Holding Time from Sample Date
Groundwater for trend analysis	water	PVOCs	SW846 8260B						glass vial	2-40 ml	HCl to pH<2, Zero Headspace, Cool to 4° ≥ 2°C	14 days
		PAHs	SW846 8270C GC/MS SIM						amber glass	2 liters	Cool to 4° ≥ 2°C	14 days
		Phenols	SW846 9066						amber glass	1 liters	H_2SO_4 to pH<2 Cool to 4° ≥ 2°C	28 days
		Cyanide, total	SW846 9012A						plastic	500 ml	NaOH ≥ 12 Cool to 4° ≥ 2°C	14 days
		Cyanide, available	USEPA OIA 1677						amber glass	250 ml	NaOH ≥ 12 Cool to 4° ≥ 2°C $PbCO_3$ & filter if S^{-2} present $C_6H_8O_6$ if Cl, OCl^-, SO_3^{-2} present $C_2H_8N_2$ if soluble $O=CH^-$ present	14 days
		MGP Metals[7]	SW846 6020A SW846 7470A						plastic	600 ml	HNO_3 to pH<2 Cool to 4° ≥ 2°C	6 months
		Alk (bi-carb)	USEPA 310.2						plastic	100 ml	Cool to 4° ≥ 2°C	14 days
		Alk (carb)	USEPA 310.2						plastic	100 ml	Cool to 4° ≥ 2°C	14 days
		Ammonia	USEPA 350.1						plastic	500 ml	H_2SO_4 to pH<2 Cool to 4° ≥ 2°C	28 days
		Chloride	USEPA 300.0, 325.1						plastic	50 ml	Cool to 4° ≥ 2°C	28 days
		Total Hardness	SW846 6010						plastic	100 ml	H_2SO_4 to pH<2 Cool to 4° ≥ 2°C	6 months
		Nitrate	USEPA 353.2, 300.0, 9056						plastic	100 ml	H_2SO_4 to pH<2 Cool to 4° ≥ 2°C	48 hours
		Sulfate	USEPA 300.0, 9056						plastic	50 ml	Cool to 4° ≥ 2°C	28 days
		Sulfide	USEPA 9030						plastic	500 ml	NaOH, 20 drops zinc acetate to pH>9, Cool to 4° ≥ 2°C	7 days
		Ferrous Iron	SW846 6020A						plastic	8 oz.	Cool to 4° ≥ 2°C	upon receipt
		TDS	USEPA 160.1						plastic	100 ml	Cool to 4° ≥ 2°C	7 days
		TKN	USEPA 351.1						plastic	500 ml	H_2SO_4 to pH<2 Cool to 4° ≥ 2°C	28 days
		TSS	USEPA 160.2						plastic	100 ml	Cool to 4° ≥ 2°C	7 days
		TOC	USEPA 415.1, 9060						plastic	(3) 40 ml	H_2SO_4 to pH<2 Cool to 4° ≥ 2°C	28 days
		Temperature	field instruments						field measured	n/a	n/a	immediate field measurement
		pH	field instruments						field measured	n/a	n/a	immediate field measurement
		Specific Conductivity	field instruments						field measured	n/a	n/a	immediate field measurement
		Oxidation-Reduction Potential	field instruments						field measured	n/a	n/a	immediate field measurement
		DO	field instruments						field measured	n/a	n/a	immediate field measurement
		Turbidity	field instruments						field measured	n/a	n/a	immediate field measurement

Table 1. Multi-Site Field Sampling Plan Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Sample Type/Location[1]	Matrix	Parameter [2]	Method	Sample Quantity [3]	Field Duplicates [4]	Equipment Blanks [5]	MS/MSD[6]	TOTAL	Container Type	Minimum Volume	Preservation	Holding Time from Sample Date
Surface water for human health and ecological risk assessments	water	PVOCs	SW846 8260B						glass vial	2-40 ml	HCl to pH<2, Zero Headspace, Cool to 4° ≥ 2°C	14 days
		PAHs	SW846 8270C GC/MS SIM						amber glass	2 liters	Cool to 4° ≥ 2°C	14 days
		Phenols	SW846 9066						amber glass	1 liters	H_2SO_4 to pH<2 Cool to 4° ≥ 2°C	28 days
		Cyanide, total	SW846 9012A						plastic	500 ml	NaOH ≥ 12 Cool to 4° ≥ 2°C	14 days
		Cyanide, available	USEPA OIA 1677						amber glass	250 ml	NaOH ≥ 12 Cool to 4° ≥ 2°C $PbCO_3$ & filter if S^{-2} present $C_6H_8O_6$ if Cl, OCl^-, SO_3^{-2} present $C_2H_8N_2$ if soluble $O=CH^-$ present	14 days
		MGP Metals[7]	SW846 6020A SW846 7470A						plastic	600 ml	HNO_3 to pH<2 Cool to 4° ≥ 2°C	6 months
		Percent Solids	160						glass	4 oz	Cool to 4° ≥ 2°C, dark	28 days
		TOC	USEPA 415.1, 415.2						plastic	100 g	Cool to 4° ≥ 2°C, dark	28 days
		Temperature	field instruments						field measured	n/a	n/a	immediate field measurement
		pH	field instruments						field measured	n/a	n/a	immediate field measurement
		Specific Conductivity	field instruments						field measured	n/a	n/a	immediate field measurement
		Oxidation-Reduction Potential	field instruments						field measured	n/a	n/a	immediate field measurement
		DO	field instruments						field measured	n/a	n/a	immediate field measurement
		Turbidity	field instruments						field measured	n/a	n/a	immediate field measurement
Groundwater and Surface Water Waste Characterization *Parameters vary on a site-specific basis*	Water	PVOCs	SW846 8260B						glass vial	2-40 ml	HCl to pH<2, Zero Headspace, Cool to 4° ≥ 2°C	14 days
		PAHs	SW846 8270C GC/MS SIM						amber glass	2 liters	Cool to 4° ≥ 2°C	14 days
		Cyanide, total	SW846 9012A						plastic	500 ml	NaOH ≥ 12 Cool to 4° ≥ 2°C	14 days
		MGP Metals[7]	SW846 6020A, 7470A						plastic	600 ml	HNO_3 to pH<2 Cool to 4° ≥ 2°C	6 months
		Percent Solids	160						glass	4 oz	Cool to 4° ≥ 2°C, dark	28 days
		TSS	USEPA 160.2						plastic	100 ml	Cool to 4° ≥ 2°C	7 days

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Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Sample Type/Location[1]	Matrix	Parameter [2]	Method	Sample Quantity [3]	Field Duplicates [4]	Equipment Blanks [5]	MS/MSD[6]	TOTAL	Container Type	Minimum Volume	Preservation	Holding Time from Sample Date
Groundwater and Surface Water Waste Characterization continued…	Water	TOC	USEPA 415.1, 9060						plastic	(3) 40 ml	H_2SO_4 to pH<2 Cool to 4° ≥ 2°C	28 days
		Temperature	field instruments						field measured	n/a	n/a	immediate field measurement
		pH	field instruments						field measured	n/a	n/a	immediate field measurement
		Specific Conductivity	field instruments						field measured	n/a	n/a	immediate field measurement
		Oxidation-Reduction Potential	field instruments						field measured	n/a	n/a	immediate field measurement
		DO	field instruments						field measured	n/a	n/a	immediate field measurement
		Turbidity	field instruments						field measured	n/a	n/a	immediate field measurement
Sediment for ecological risk assessments (typically 0 to 6 inches below mudline)	sediment	PVOCs	SW846 8260B						glass	2 oz.	methanol, Cool to 4° ≥ 2°C	7/28 days
		34 PAHs[8]	SW846 8270C GC/MS SIM						amber glass	4 oz.	Cool to 4° ≥ 2°C	14/40 days
		Cyanide	SW846 9012A						plastic	125 ml	Cool to 4° ≥ 2°C	14 days
		MGP Metals[7]	SW846 6020A SW846 7470A						glass	16 oz	Cool to 4° ≥ 2°C	6 months
		Phenols	SW846 9066						amber glass	250 ml	Cool to 4° ≥ 2°C	28 days
		"Soot" Carbon[9]	Gusstaffson et al.						Plastic	500 g	Cool to 4° ≥ 2°C, dark	28 days
		Percent Solids	160						glass	4 oz	Cool to 4° ≥ 2°C, dark	28 days
		TOC	USEPA 415.1						plastic	100 g	Cool to 4° ≥ 2°C, dark	28 days
		Description	ASTM D 2488						field measured	n/a	n/a	immediate field measurement
		Biological Testing[10]	Method 100.4						Plastic	2L	Cool to 4° ≥ 2°C, dark	
Sediment for Human Health Risk Assessment (typically 0 to 2 feet below mudline)	sediment	PVOCs	SW846 8260B						glass	2 oz.	methanol, Cool to 4° ≥ 2°C	7/28 days
		PAHs	SW846 8270C GC/MS SIM						amber glass	4 oz.	Cool to 4° ≥ 2°C	14/40 days
		Cyanide	SW846 9012A						plastic	125 ml	Cool to 4° ≥ 2°C	14 days
		MGP Metals[7]	SW846 6020A SW846 7470A						glass	16 oz	Cool to 4° ≥ 2°C	6 months
		Phenols	SW846 9066						amber glass	250 ml	Cool to 4° ≥ 2°C	28 days
		Percent Solids	160						glass	4 oz	Cool to 4° ≥ 2°C, dark	28 days
		TOC	USEPA 415.1						plastic	100 g	Cool to 4° ≥ 2°C, dark	28 days
		Description	ASTM D 2488						field measured	n/a	n/a	immediate field measurement

Table 1. Multi-Site Field Sampling Plan Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Sample Type/Location[1]	Matrix	Parameter [2]	Method	Sample Quantity [3]	Field Duplicates [4]	Equipment Blanks [5]	MS/MSD[6]	TOTAL	Container Type	Minimum Volume	Preservation	Holding Time from Sample Date
Soil and Sediment Remedial Alternatives and Waste Characterization (depth varies)	soil	COPC[11]	various						plastic	5 gal.	various	various
		Protocol B	various						glass	26 oz.	VOCs, methanol, cool to 4°C, dark; Others cool to 4°C, dark	varies
		Specific Gravity	ASTM D 854						glass	8 oz.	n/a	6 months
		Grain Size Distribution	ASTM D 421, D 422						plastic	5 gal.	n/a	6 months
		Atterberg Limits	ASTM D 4318						glass or plastic	8 oz.	n/a	6 months
		TOC	USEPA 415.1						glass	125 ml	Cool to 4° ≥ 2°C, dark	28 days
		Modified Proctor	ASTM D 1557						glass or plastic	8 oz.	n/a	6 months
		Shear Strength	Pocket Penetrometer or Torvane						field measured	n/a	n/a	immediate field measurement
		Moisture Content	ASTM D 2216						plastic	8 oz.	Cool to 4° ≥ 2°C, dark	7 days

References:
(1) Test Methods for Evaluating Solid Wastes, USEPA SW-846, revised 1991.
(2) Code of Federal Regulations Chapter 40 Part 136.

Notes:
1. Sample locations will be provided in Site-Specific Work Plans.
2. Parameter list includes anticipated constituents of concern as identified in the Generalized Conceptual Site Model and Multi-Site Risk Assessment Framework. Constituents to be analyzed will be identified in Site-Specific Work Plans. The table provided herein is provided as an example parameter list.
   EPA-approved methods published in References 1 and 2 above may be used. The list of analytes, laboratory method and the method detection limit for each parameter are included in Tables 2 through 5 of the QAPP for each matrix.
3. Sample media and quantities to be determined in Site-Specific Work Plans.
4. Field duplicates collection frequency - one per group of ten or fewer investigative water samples and one per group of twenty or fewer investigative soil samples.
5. Equipment blanks will be collected at a frequency of one per sampling day with non-dedicated sampling equipment.
6. Matrix Spike/Matrix Spike Duplicate (MS/MSD) sample frequency - one per group of 20 or fewer investigative water samples. Laboratory requirements will determined additional volume.
7. MGP Metals as determined in the Generalized Conceptual Site Model and Multi-Site Risk Assessment Framework.
8. May include a list of 34 PAHs, including parent and alkylated parameters as provided in USEPA Guidance Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures, 2002 by SW-846 Method 8270C with gas chromatograph/mass spectrometry in selected ion mode of operation.
9. "Soot" Carbon is the remaining carbon after muffle furnace drying and acid treatment of sediments to remove other forms of carbon. Used to estimate the bioavailable concentration of PAHs in sediment from the "freely-dissolved" chemical in the interstitial water based on USEPA Bioavailability Procedure, 2000, Gustafsson, et al. 1997, and Accardi-Day and Gschwend, 2003.
10. The *Hyallella* (amphipod) 28-day test may be used to evaluate the toxicity of whole sediments. This test will be performed to a 28-day survival and growth endpoint modified from USEPA Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates, Second Edition, Method 100.4 (EPA/600/R-99/064).
11. Constituents of Potential Concern vary on a site-by-site basis.

Acronyms:
Alk (bi-carb) = Bi-carbonate alkalinity
Alk (carb) = Carbonate alkalinity
BTEX = Benzene, Toluene, Ethylbenzene, Xylenes
DO = Dissolved Oxygen (field measured)
DOC = Dissolved Organic Carbon
MS/MSD = Matrix Spike/Matrix Spike Duplicate
PAHs = Polynuclear Aromatic Hydrocarbons
TOC = Total Organic Carbon
TSS = Total Suspended Solids
VOC = Volatile Organic Compounds

Geotechnical Parameter Methods:
Atterberg Limit = ASTM D 4318
TOC = Walkey Black Method
Grain size Distribution = ASTM D 421, D 422
Shear Strength = ASTM D 3080
Modified Proctor = ASTM D 1557
Recompacted Permeability = ASTM D 5084
Moisture Content = ASTM D 2216

Table 2. Field Sampling Option Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

	FIELD SAMPLING AND ANALYSIS MATRIX: FIELD SAMPLING AND COLLECTION TECHNIQUES								
	Soil Impact	GW Impact	Surface Water Impact	Air Impact	Depth (feet)	Production Rate (Time)	Derived Waste Volume	Technology Status	Relative Cost Per Sample
ACCESS TOOLS									
Non-Lithified Material									
Hollow-Stem Auger	Min	Mod	na	Max	≤ 100	Short	Large	Routinely used	$$
Mud Rotary	Mod	Max	na	Max	≥ 100	Short	Large	Routinely used	$$
Directional Drilling	Mod	Mod	na	Max	≤ 100	Short	Large	Routinely used	$$$
Solid Flight and Bucket Augers	Min	Max	na	Max	≤ 100	Short	Large	Routinely used	$$
Jetting Methods	Max	Max	na	Max	≤ 100	Quick	Large	Routinely used	$
Sonic Drilling	Min	Mod	na	Max	≥ 100	Quick	Small	Moderate field experience	$$$
Lithified Material									
Direct Air Rotary with Rotary Bit / Downhole Hammer	Min	Mod	na	Max	≥ 100	Short	Large	Routinely used	$$
Cable Tool	Min	Mod	na	Max	≥ 100	Extended	Medium	Routinely used	$$
Rotary Diamond Drilling	Min	Mod	na	Max	≥ 100	Extended	Large	Routinely used	$$$
Direct Push Technology									
Cone Penetrometer	Min	Min	na	Min	≤ 100	Quick	Small	Routinely used	$$
Direct Push Sampler	Min	Mod	na	Mod	≤ 100	Quick	Small	Moderate field experience	$
Sampling Installations for Portable Samplers									
Driven Wells	na	Min	na	Mod	≤ 100	Quick	Small	Routinely used	$
Single Riser / Limited Interval Wells	na	Min	na	Mod	≤ 100	Quick	Large	Routinely used	$$
Nested Wells / Single Borehole	na	Min	na	Mod	≤ 100	Extended	Large	Moderate field experience	$$
Sampling Installations for Portable Samplers - continued									
Nested Wells / Multiple Boreholes	na	Min	na	Mod	≤ 100	Extended	Large	Moderate field experience	$$
Portable In-Situ Ground Water Samplers / Sensors									
Direct Drive Samplers	na	Min	Min	Mod	≤ 100	Short	Small	Moderate field experience	$
Passive Multilayer Samplers	na	Min	na	Min	≤ 100	Short	Small	Moderate field experience	$
Fixed In-Situ Samplers									
Multilevel Capsule Samplers	na	Min	na	Mod	≤ 100	Short	Medium	Moderate field experience	$$
Multiple-Port Casings	na	Min	na	Mod	≤ 100	Short	Medium	Moderate field experience	$
Passive Multilayer Samplers	na	Min	na	Min	≤ 100	Short	Small	Moderate field experience	$

Table 2. Field Sampling Option Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

	FIELD SAMPLING AND ANALYSIS MATRIX: FIELD SAMPLING AND COLLECTION TECHNIQUES								
	Soil Impact	**GW Impact**	**Surface Water Impact**	**Air Impact**	**Depth (feet)**	**Production Rate (Time)**	**Derived Waste Volume**	**Technology Status**	**Relative Cost Per Sample**
Destructive Sampling Methods									
Coring and Extraction	na	Min	na	Mod	≤ 100	Short	Medium	Moderate field experience	$
Temporary Installations	na	Min	na	Mod	≤ 100	Short	Medium	Routinely used	$
COLLECTION TOOLS									
Hand-Held Methods									
Scoops, Spoons, and Shovels	Min	na	na	na	≤ 25	Quick	Small	Routinely used	$
Augers	Min	Max	na	Max	≤ 25	Quick	Small	Routinely used	$
Tubes	Min	na	na	na	≤ 25	Quick	Small	Routinely used	$
Power-Driven Soil Samplers									
Split and Solid Barrel	Min	na	na	na	≤ 25	Quick	Small	Routinely used	$
Rotating Core	Min	na	na	na	≤ 25	Short	Medium	Moderate field experience	$$
Thin-Wall Open Tube	Min	na	na	na	≤ 25	Quick	Small	Routinely used	$$
Thin-Wall Piston / Specialized Thin Wall	Min	na	na	na	≤ 25	Quick	Small	Routinely used	$$
Portable Positive Displacement									
Bladder Pump	na	Min	Min	na	≥ 100	Quick	Medium	Routinely used	$$
Gear Pump	na	Min	Min	na	≤ 100	Short	Medium	Limited field experience	$$
Submersible Helical Rotor Pump	na	Min	Min	na	≤ 100	Short	Medium	Limited field experience	$$$
Gas-Driven Displacement Pumps	na	Min	Min	na	≤ 100	Short	Medium	Routinely used	$
Gas-Driven Piston Pumps	na	Min	Min	na	≥ 100	Short	Medium	Moderate field experience	$$$
Other Portable Ground Water Sampling Pumps									
Suction-Lift Pumps (peristaltic)	na	Min	Min	na	≤ 25	Short	Medium	Routinely used	$
Submersible Centrifugal Pump	na	Min	Min	na	≥ 100	Short	Medium	Routinely used	$$$
Other Portable Ground Water Sampling Pumps - continued									
Inertial-Lift Pumps	na	Min	Min	na	≤ 100	Short	Medium	Moderate field experience	$
Portable Grab Samplers									
Bailer	na	Min	Min	na	≥ 100	Short	Large	Routinely used	$
Pneumatic Depth-Specific Samplers	na	Min	Min	na	≥ 100	Short	Small	Moderate field experience	$$
Mechanical depth-Specific Samplers	na	Min	Min	na	≥ 100	Short	Large	Routinely used	$

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Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

	FIELD SAMPLING AND ANALYSIS MATRIX: FIELD SAMPLING AND COLLECTION TECHNIQUES								
	Soil Impact	GW Impact	Surface Water Impact	Air Impact	Depth (feet)	Production Rate (Time)	Derived Waste Volume	Technology Status	Relative Cost Per Sample
Extractive Collection Methods									
Soil Water Extraction	Min	Max	Max	na	≤ 100	Extended	Small	Moderate field experience	$$
Sorbent Devices	na	Min	Min	Min	na	Short	Small	Routinely used	$
Biological Indicators	Min	Min	Min	Min	na	Extended	Medium	Moderate field experience	$$
Gas / Air Collection Methods									
Soil Gas Sampling (static)	na	na	na	Min	≤ 25	Short	Small	Routinely used	$
Soil Gas Probes	na	na	na	Min	≤ 100	Quick	Small	Routinely used	$
Air Sampling Devices	na	na	na	Min	na	Short	Small	Routinely used	na
EXTRACTION METHODS									
Solvent Extraction	Min	Mod	Mod	na	na	Short	Large	Moderate field experience	$$
Thermal Digestion	Min	Min	Min	na	na	Quick	Medium	Moderate field experience	$$
Thermal Extraction / Desorption	Min	Min	Min	na	na	Quick	Medium	Moderate field experience	$$
Purge and Trap	Min	Min	Min	na	na	Quick	Medium	Routinely used	$$
Headspace	Mod	Mod	Mod	Min	na	Quick	Medium	Routinely used	$
Supercritical Fluid Extraction	Min	Mod	Mod	na	na	Quick	Medium	Limited field experience	$$$
Membrane Extraction	na	Min	Min	Min	na	Quick	Small	Limited field experience	$$
Sorbent Extraction	na	Min	Min	Min	na	Quick	Small	Moderate field experience	$

Note: Ratings are based on USEPA screening opinions for dynamic field sampling goals (http://www.frtr.gov/site/).

$: Least Expensive
$$: Mid-range Expensive
$$$: Most Expensive
Min : Minimum
Mod : Moderate
Max : Maximum
na : Not Applicable

Table Source :
Federal Remediation Technologies Roundtable, 2006, Technology Screening Web Site, http://www.frtr.gov/site/

Table 3. Field Analysis Option Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

	Sample Media			Performance Ratings									
	Soil / Sediment	Water	Air	Selectivity	Susceptibility to Interference	Detection Limits	Turn Around Time Per Sample	Screen / Identify	Characterize / Quantify	Cleanup Performance	Long-Term Monitoring	Quantitative Data Capabilities	Relative Cost per Analysis
VOCs, SVOCs, and Pesticides													
In-Situ Analysis													
Solid / Porous Fiber Optic	E	B	A	I	Low	Midrange	Minutes	B	A	B	A	yes	$
Laser Induced Fluorescence	A	B	na	I	Medium	Midrange	Minutes	B	A	B	A	yes	$
Ex-Situ Analysis													
Photoionization Detector	E	E	B	I	High	Midrange	Minutes	B	S	B	S	yes	$
Flame-Ionization Detector	E	E	B	I	High	Low	Minutes	B	S	B	S	yes	$
Explosimeter	E	E	B	P	High	Midrange	Minutes	B	S	B	S	yes	$
Gas chromatography (GC) plus detector	E	E	B	D	Low	Low	Hours	B	B	B	B	yes	$$
Catalytic Surface Oxidation	E	E	B	I	Medium	Midrange	Minutes	B	A	B	B	yes	$
Detector Tubes	E	E	B	I	Medium	Midrange	Minutes	B	S	B	S	yes	$
Mass Spectrometry (MS)	E	E	B	D	Medium	Midrange	Hours	A	B	B	A	yes*	$$$
GC / MS	E	E	B	D	Low	Low	>1 day	B	B	B	A	yes	$$$
GC/Ion Trap MS	E	E	B	D	Low	Low	Hours	A	B	B	A	yes*	$$$
Ion Trap MS	E	E	B	D	Medium	Low	Hours	B	B	B	B	yes	$$$
Ion Mobility Spectrometer	E	E	B	D	Medium	Low	Minutes	B	A	B	A	yes	$$
Ultraviolet (UV) Fluorescence	A	B	A	P	Medium	Low	Hours	B	A	B	B	yes	$$
Synchronous Luminescence/Fluorescence	E	B	A	I	Medium	Low	Hours	B	A	B	B	yes	$$
UV-Visible Spectrophotometry	E	B	A	P	High	Low	Minutes	B	A	B	B	yes	$$
Infrared Spectroscopy	E	E	B	I	High	Midrange	Minutes	B	A	B	B	yes	$$
Fourier Transform Infrared (FTIR) Spectroscopy	E	E	B	D	Medium	Low	Minutes	B	A	B	B	yes	$$
Scattering / Absorption LIDAR	E	E	B	P	High	High	Minutes	B	A	B	B	yes	$$

Table 3. Field Analysis Option Summary
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USEPA Region 5
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	Sample Media			Performance Ratings									
	Soil / Sediment	Water	Air	Selectivity	Susceptibility to Interference	Detection Limits	Turn Around Time Per Sample	Screen / Identify	Characterize / Quantify	Cleanup Performance	Long-Term Monitoring	Quantitative Data Capabilities	Relative Cost per Analysis
VOCs, SVOCs, and Pesticides Ex-Situ Analysis - continued													
Raman Spectroscopy/Surface Enhanced Raman Scattering (SERS)	E	B	E	P	High	Low	Minutes	B	A	B	B	yes	$$
Near IR Reflectance/Transmittance Spectroscopy	B	na	na	P	High	High	Minutes	B	A	B	B	yes	$$
Immunoassay Colorimetric Kits	B	B	na	I	Medium	Midrange	Minutes	B	A	B	A	yes	$
Amperometric and Galvanic Cell Sensor	E	na	B	D	Medium	Low	Minutes	B	A	B	B	yes	$
Semiconductor Sensors	E	B	B	I	Medium	Low	Minutes	B	A	B	B	yes	$
Piezoelectric Sensors	E	E	B	D	High	Low	Minutes	B	A	B	B	yes	$
Field Bioassessment	B	B	B	P	High	na	>1 day	B	B	S	A	yes	$$$
Toxicity Tests	B	B	B	P	High	na	Hours	B	B	S	B	yes	$
Room-Temperature Phosphorimetry	A	B	A	D	High	Low	Hours	B	A	B	B	yes	$$
Chemical Colorimetric Kits	A	B	na	I	Medium	Midrange	Minutes	B	A	B	B	yes	$
Free Product Sensors	na	B	na	P	Low	High	Minutes	B	B	B	B	yes	$
Ground Penetration Radar	A	S	na	P	High	High	>1 day	A	B	A	A	yes*	$$
Thin-Layer Chromatography	E	B	na	I	Medium	Low	Hours	B	B	B	B	yes	$$$
METALS													
Ex-Situ Analysis													
Atomic Absorption (AA) Spectroscopy	E	E	B	D	Low	Low	>1 day	S	B	S	A	no	$$$
Inductively-Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES)	E	E	B	D	Low	Low	Hours	S	B	S	A	no	$$$
X-Ray Fluorescence	B	B	E	D	Low	Midrange	Minutes	B	A	B	A	yes	$
Chemical Colorimetric Kits	A	B	na	D	Medium	Midrange	Hours	B	A	B	B	yes	$

Table 3. Field Analysis Option Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

	Sample Media			Performance Ratings									
	Soil / Sediment	Water	Air	Selectivity	Susceptibility to Interference	Detection Limits	Turn Around Time Per Sample	Screen / Identify	Characterize / Quantify	Cleanup Performance	Long-Term Monitoring	Quantitative Data Capabilities	Relative Cost per Analysis
Titrimetry Kits	A	B	na	D	Medium	Midrange	Hours	B	A	B	B	yes	$
Metals Ex-Situ Analysis - continued													
Immunoassay Colorimetric Kits	B	B	na	I	Medium	Low	Minutes	B	A	B	B	yes	$
Anodic Stripping Voltammetry	E	B	na	D	Medium	Low	Minutes	A	B	B	A	yes*	$$
Fluorescence Spectrophotometry	E	E	B	D	Medium	Low	Minutes	B	B	B	B	yes	$$
Amperometric and Galvanic Cell Sensor	E	B	na	D	Medium	Midrange	Minutes	B	A	B	B	yes	$
Field Bioassessment	B	B	B	P	High	na	>1 day	B	B	S	A	yes	$$$
Toxicity Tests	B	B	B	P	High	na	Hours	B	B	S	B	yes	$
Ion Chromatography	E	B	na	I	Medium	Low	Minutes	B	B	B	B	yes	$$

Note: Ratings are based on USEPA screening opinions for dynamic field sampling goals (http://www.frtr.gov/site/).

B : Better
E : Requires selection of extraction procedure
A : Adequate
S : Serviceable
na : Not Applicable
*** :** with additional effort
I : Measures the contaminant indirectly
D : Measures the specific contaminant directly
P : Measures a part of the compound

Low : 100-1000 ppb (soil); 1-50 ppb (water)
Midrange : 10-100ppm (soil); 0.5-10ppm (water)
High : 500+ ppm (soil); 100+ ppm (water)
$: Least Expensive
$$: Mid-range Expense
$$$: Most Expensive

Table Source : Federal Remediation Technologies Roundtable, 2006, Technology Screening Web Site, http://www.frtr.gov/site/

Table 4. Surface Geophysical Methods Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Applications	Geophysical Options
Assessing Natural Geologic And Hydrogeologic Conditions	
Depth and Thickness of Soil and Rock Layers	Radar / Gravity / EM Time / Resistivity / Refraction / Reflection
Mapping Lateral Variations in Soil and Rock	
Larger regional structural features (major synclines and faults)	Radar / Gravity / EM Time / Resistivity / Refraction / Reflection / Magnetic / Thermal
Smaller local features (permeable zones, joints, faults, karst, cavities and subsidence, synclines, grabbens, buried channels)	Radar / Gravity / EM Time / VLF / Resistivity / SP / Refraction / Reflection / Magnetic / Metal Detector / Gravity / Thermal / Radiation
Depth of Water Table	Radar / Gravity / EM Time / Resistivity / Refraction / Reflection
Locating And Mapping Contaminant Plumes And Spills	
Assessing Natural Geologic And Hydrogeologic Conditions Delineate Pathways And Trap	Radar / Gravity / EM Time / VLF / Resistivity / SP / Refraction / Reflection / Magnetic / Gravity / Thermal / Radiation
Inorganics (electrically conductive, i.e. landfill, leachate, salt water intrusion, acids)	
Mapping horizontal extent	Radar / Gravity / Resistivity
Defining vertical extent	Radar / Gravity / EM Time / Resistivity
Organics	
Floaters	Radar / Gravity / Resistivity
Mixers (do not detect with geophysics)	Radar
Sinkers (DNAPLS; limited detection with geophysics)	Radar
Locating And Mapping Fill, Buried Wastes, Drums, Or Other Underground Structures And Utilities	
Buried Bulk Wastes - without metal	Radar / Gravity / Resistivity / Reflection
Buried Bulk Wastes - with metal	Radar / Gravity / Resistivity / Refraction / Magnetic / Metal Detector
Depth of Buried Trenches and Landfills	Radar / EM Time / Resistivity / Refraction / Magnetic / Thermal
Detection of 55-gallon Steel Drums	Radar / Gravity / Magnetic / Metal Detector
Buried Pipes and Tanks	Radar / Gravity / Magnetic / Metal Detector
Mapping of Utility Trenches (as potential pathways of contaminant migration)	Radar / Gravity / Magnetic / Metal Detector / Thermal
Location Of Abandoned Wells With Steel Casings	Magnetic / Thermal

Table 4. Surface Geophysical Methods Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Applications	Geophysical Options
Evaluation Of Man-Made Soil, Rock Or Concrete Structures	
Earthen Dams	Radar / Gravity / EM Time / Resistivity / Refraction / Thermal
Concrete / Rebar	Radar / Thermal
Roads and Runways	Radar / Thermal
Concrete Dams, Tunnels, and Foundations	Radar / Thermal
Seepage	
Pipe, Joint Failure (resulting in soil piping and surface subsidence)	Radar / Gravity / Thermal
Mine Induced Subsidence	Radar / Gravity / Resistivity / Thermal
Locating and Mapping of Abandoned Mines, Tunnels, etc.	Radar / Gravity / EM Time / Resistivity / Refraction / Reflection / Gravity / Radiation

Radar : Ground Penetrating Radar
EM Freq. : Frequency Domain Electromagnetics (EM)
EM Time : Time Domain Electromagnetics
VLF : Very Low Frequency
SP : Spontaneous Potential
Refraction : Seismic Refraction
Reflection : Seismic Reflection

Note: Source - Technos, Inc., 1992, *Technotes Vol. 1 - Surface Geophysics* .

Table 5. Borehole Geophysical Methods Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Log	Parameter Measured Or Calculated	Applications
Borehole Nuclear Logs		
Gamma	Total count rate of natural gamma radiation	Identification of soil and rock lithology, stratigraphic correlation, and relative porosity of soil and rock based upon clay content.
Gamma Spectrometry	Identification and quantitative analysis of the radioisotopes that contribute to the total count rate	Identification of soil and rock lithology, characterize mineralogy based upon radio isotopes, identify natural and artificial radio isotopes migrating in ground water for tracers.
Gamma-Gamma (Density)	Relative density or true density if calibrated	Bulk density determinations, also used as a cement bond log in monitoring wells
Neutron (Moisture/Porosity)	Moisture/fluid content of soil and rock	Provides moisture content above the water table, porosity below the water table.
Borehole Electrical / Electromagnetic Logs		
Induction	Bulk electrical conductivity of soil, rock, and pore fluids and magnetic susceptibility	Identification of soil and rock lithology, stratigraphic correlation. Indicate clay content based upon conductivity. Estimate porosity based upon fluid content.
Resistivity	Electrical resistivity of soil, rock and pore fluids	Measure of contaminants presence based upon fluid conductivity.
Single Point Resistance	Electrical resistance of soil, rock and pore fluids	Measure of contaminants present in a soil and rock (based upon fluid conductivity Identification of soil and rock lithology, stratigraphic correlation. Fracture detection in rock.
Spontaneous Potential (SP)	Voltage. Responds to electrochemical effects of differences in borehole fluids and oxygen reduction of minerals also due to streaming potential due to movement of pore fluids	Identification of soil and rock lithology, stratigraphic correlation. Flow and fracture detection in rock.
Dipmeter	Resistivity of formation	Determine dip of strata.
Radar (Min. OD 2-6 in.)	Travel time of the electromagnetic wave (Distance is calculated)	Identification of anomalous conditions, far a field from the borehole, such as fractures, cavities, tunnels and mines. Flow path analysis. using the saline trace method. Can also be used hole to hole.
Metal Detector	Responds to ferrous or non-ferrous metal	Location of drilling hazards, rebar in concrete or other well problems.

Table 5. Borehole Geophysical Methods Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Log	Parameter Measured Or Calculated	Applications
Borehole Fluid Logs		
Conductivity	Electrical conductivity of borehole fluids	Provides a measure of borehole fluid, specific conductance (or total dissolved solids). Assess movement of water into or out of borehole locating permeable or fracture zones. Determine salt water interface.
Flow Meter (Movement)	Movement of fluid within the borehole	Locating permeable or fracture zones by movement of water into or out of borehole. Provides a means to estimate or calculate hydraulic conductivity.
Flow (Tracers)	Detection of tracers within the borehole fluid	Measures flow into and out of borehole. Used with pump tests locating permeable or fracture zones. Provides means to estimate or calculate hydraulic conductivity. Can be used to assess leaks in casing.
Temperature	Temperature of borehole fluid	Locating permeable or fracture zones by movement of water into or out of borehole. Also used for temperature correction to other logs and measurements.
In-Situ Chemical Sensors (Min. OD 2-6 in.)	Selected chemical parameters of the borehole fluid	Movement of temperature, conductivity, pH, oxygen, Eh, specific ion electrodes, tracers.
Borehole Mechanical Logs		
Caliper	Diameter of borehole or casing	Measure borehole or casing diameter for corrections to other logs, and location of large fractures and cavities.
Deviation	Inclination and direction of borehole (deviation from vertical	Correction to televiewer and other logs as well as borehole to borehole measurements.
Borehole Acoustic / Sonic / Seismic Logs		
Acoustic Televiewer (OD Min 3-in, Max 16-in)	Acoustic reflections from borehole wall	Provides a high frequency acoustic image of borehole wall to define strike, dip and aperture of fractures.
Sonic or Full Wave Sonic (Acoustic velocity)	Travel time and magnitude of seismic signal in soil and rock	Soil and rock porosity, lithology, fracture detection, compressive strength related to velocity, elastic moduli determination. Assessment of cement bond.
Vertical Seismic Profiling (VSP) (Min 2- to 3-in OD)	Seismic travel time in soil and rock	Provides vertical seismic velocities from the surface to the maximum depth of the borehole. Data is used to model and interpret seismic refraction and reflection data and can also be used for engineering purposes.
Scanning Sonar (Min 3-in OD)	Travel time of acoustic signal (distance is calculated)	Size and shape determination of large cavities in water-filled boreholes.

Table 5. Borehole Geophysical Methods Summary
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Log	Parameter Measured Or Calculated	Applications
Visual Logs		
Television	Visual image of borehole or casing	Identification of lithology. Location of fractures and cavities. Inspection of piezometers, wells, or structure.
Remote Operated Vehicle (ROV) (Min 6-in OD)	Visual image of well, pipe, tunnel or cavity	Used for video inspection of large diameter boreholes, wells and pipes, tunnels or cavities. Can be adapted to certain sampling and other work tasks within larger areas or cavities.
Other Logs		
Magnetometer	Magnetic susceptibility responds to presence of ferrous metals	Exploration for ferrous minerals. Location of steel casing, drilling hazards, or other well problems.
Gravity (Min 5-in OD)	Changes in density of soil and rock	Provide far-field measurements of changes in soil or rock density indicating material type. Data used for structural geologic evaluation, estimating change in porosity, and fracture or cavity detection.

Min. : Minimum
Max. : Maximum
OD : Outside diameter of borehole
in. : inch
Note: Source - Technos, Inc., 1992, Technotes Vol. 2 - Borehole Geophysics.

Table 6. Key Empirical Methods to Evaluate Sediment and Contaminant Movement (USEPA OSWER)
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Highlight 2-10: Key Empirical Methods to Evaluate Sediment and Contaminant Movement
Bathymetry (evaluates net change in sediment surface elevations) •Single point/local area devices •Transects/cross-sections (with known vertical and horizontal accuracy) •Longitudinal river profiles along the thalweg (i.e., location of deepest depth) •Acoustic surveys (with known vertical and horizontal accuracy) •Comparison to dredging records, aerial photos, overall geomorphology Contaminant data (from continuous cores, surface sediment, and water column): •Time-series observations (event scale and long-term seasonal, annual, decade-scale) •Comparison of core pattern or changing pattern in surface sediment, with pollutant loading history •Comparison of concentration patterns during and after high energy events Sediment data (e.g., from continuous cores or surface samples): •Patterns of grain-size distribution (McLaren and Bowles 1985, McLaren et al. 1993, Pascoe et al. 2002) •In-situ or ex-situ erosion measurement devices [e.g., SEDFLUME (Jepsen et al. 1997, McNeil et al. 1996), PES (Tsai and Lick 1986), Sea Carousel (Maa et al. 1993), or Inverted Flume (Ravens and Gschwend 1999)] •Sediment water interface camera Geochronology (evaluates continuity of sedimentation and age of sediment with depth in cores): •^{137}Cs, lignin, stable Pb (longer-lived species to evaluate burial rate and age progression with depth) •^{210}Pb, 7Be, 234Th (shorter-lived species to evaluate depth of mixing zone) •X-radiography, color density analysis Geomorphological studies: •Land and water body geometry and bathymetry; physical processes •Human modifications Sediment-contaminant mass balance studies, especially during high energy events: •Upstream and tributary loadings (grain size distributions and rating curves) •Tidal cycle sampling (in marine estuaries and coastal seas) •Sampling during the rising limb of a rain-event generated runoff hydrograph (frequently greatest erosion) Dissolved contaminant movement: •Seepage meters at sediment surface •Gradients near water body

Table Source: USEPA OSWER, 2005, Contaminated Sediment Remediation Guidance for Hazardous Waste Sites, EPA 540/R-05/012; December 2005

Table 7. Summary of Previously Obtained Analytical Methods Utilized for Soil, Sediment, Water, and Air
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

SOIL			
VOC (USEPA 8020)	PAHs (USEPA 8310)	Metals	Base-Neutral Fraction
BTEX (USEPA 8020)	Acenapthalene	Arsenic (SM 7060)	Hexachloroethane
Diesel Range Organics	Anthracene	Antimony (SM 6010)	Hexachlorobutadiene
pH (SM 150.1)	Benzo	Barium (SM 6010)	1,2,4-Trichlorobenzene
TOC (SM 451.1)	Benz(a)anthracene	Beryllium (SM 6010)	Hexachlorocyclopentadiene
COD (SM 410.1+2)	Benzo(a)pyrene	Cadmium (SM 6010)	Nitrobenzene
Oil and Grease (SM 503A)	Benzo(b)fluoranthene	Copper (SM 6010)	2-Chloronaphtalene
Chloride (SM 300.0)	Benzo(k)fluoranthene	Lead (SM 3020/7421)	Acenaphthene
Phenol, total (USEPA 420.1)	Chrysene	Mercury (SM 7470)	Isophorone
Cyanide, total and amenable (USEPA 9010)	Dibenz(a,h)anthracene	Nickel (SM 6010)	Fluorene
	Fluoranthene	Selenium (SM 7740)	2,4-Dinitrotoluene
Cyanide, dissociable(412-H)	Fluorene	Silver (SM 7760)	1,2-Diphenylhydrazine
Nitrate (SM 353.2)	Indeno(1,2,3)pyrene	Thallium (SM 6010)	2,6-Dinitrotoluene
Phosphate (SM 365.2)	Naphthalene	Zinc (SM 6010)	N-Nitrosodiphenylamine
	Phenanthrene		Hexachlorobenzene
	Pyrene		4-Bromophenyl Phenyl Ether
			4-Chlorophenyl Phenyl Ether
			Anthracene
			Phenanthrene
			Dimethyl Phthalate
			Bis-(2-chloroethyl) ether
			Di-n-butyl phthalate
			Diethyl Phthalate
			Butyl Benzyl Phthalate
			Benzidine
			Pyrene
			Fluoranthene
			Chrysene

AIR
BTEX (NIOSH 1501)
PAHs (NIOSH 5506-Mod.)
Cyanide, total
Total Suspended Particulate
Lead

WATER		
BTEX (USEPA 8020)	PAH (USEPA 8270 / 8310)	Metals
VOC (USEPA 8020)	Acenapthalene	Arsenic (SM 7060)
Diesel Range Organics	Anthracene	Antimony (SM 6010)
Phenol, total (USEPA 420.1)	Benzo	Barium (SM 6010)
Chloride (SM 325.3)	Benz(a)anthracene	Beryllium (SM 6010)
COD	Benzo(a)pyrene	Cadmium (SM 6010)
TOC	Benzo(b)fluoranthene	Copper (SM 6010)
Nitrogen	Benzo(k)fluoranthene	Lead (SM 3020/7421)
Phosphate (SM 365.2)	Chrysene	Mercury (SM 7470)
Ammonia (350.1)	Dibenz(a,h)anthracene	Nickel (SM 6010)
Nitrate (353.2)	Fluoranthene	Selenium (SM 7740)
Sulfides (376.1)	Fluorene	Silver (SM 7760)
Thiocyanates (412 L)	Indeno(1,2,3)pyrene	Thallium (SM 6010)
Sulfate (SM 375.2)	Naphthalene	Zinc (SM 6010)
Cyanide, dissociable(412-H)	Phenanthrene	
Cyanide, total (USEPA 9010 & SM 335.2)	Pyrene	
Cyanide, amenable (USEPA 9010 & SM 335.1)		

Table 8. Project Goals For Precision, Accuracy, and Completion of Field Measurements
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

	Precision Goal	Accuracy Goal	Completion Goal
Temperature (°C) [1]	± 0.1°C	± 0.4°C	90%
pH (units)	± 0.1 unit	± 0.1 unit	90%
Specific Conductance (µS/cm @ 25°C) [2]	± 100 µS/cm @ 25°C	± 100 µS/cm @ 25°C	90%
Actual Conductivity (µS/cm)[2]	± 100 µS/cm	± 100 µS/cm	90%
Turbidity (NTU)	± 0.05 NTU	± 0.05 NTU	90%
Eh (mV)	± 1.0 mV	± 1.0 mV	90%
Dissolved Oxygen (mg/L)	± 0.3 mg/L	± 0.3 mg/L	90%
Water level (feet)	± 0.01 foot	± 0.01 foot	90%

Notes:
1. °C = degrees Centigrade
2. µS/cm = microsiemens per centimeter

Table 9. Data Measurement Units for Field and Laboratory Measurements
Integrys Business Support, LLC
Former MGP Sites
USEPA Region 5
CERCLA Docket Nos. V-W-'06-C-847, V-W-'07-C-869, and V-W-'07-C-877

Parameter	Units
Atterberg Limits	percent (%)
Actual Conductivity	siemens per centimeter (S/cm)
Concentration of chemical in soil/sediment matrix	micrograms per kilogram (µg/kg) organic milligrams per kilogram (mg/kg) inorganic
Concentration of chemical in water matrix	micrograms per liter (µg/l) organic milligrams per liter (mg/l) inorganic
Dissolved Oxygen	milligrams per liter (mg/L)
Grain Size Distribution	percent (%)
Moisture Content	percent (%)
Organic Content by Loss-on-Ignition	percent (%)
pH	pH units
Specific Conductance	siemens per centimeter @ 25°C (S/cm @ 25°C)
Specific Gravity	(dimensionless)
Strength	pounds per foot inch (psf)
Temperature	degrees Celsius (°C)
Total Organic Carbon (TOC)	milligrams per kilogram (mg/kg)
Turbidity	Nephelometric Turbidity Unit (NTU)

APPENDIX A

CONSULTANT STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE
TABLE OF CONTENTS

SOP NUMBER	SOP TITLE / DESCRIPTION
SAS-01 Series	**FILE AND DATA MANAGEMENT**
SAS-01-01	Field Activity Documentation
SAS-01-02	Project File Management
SAS-02 Series	**FIELD MEASUREMENTS - GENERAL**
SAS-02-01	Equipment Calibration, Operation, and Maintenance
SAS-02-02	Surveying
SAS-03 Series	**SAMPLE COLLECTION - GENERAL**
SAS-03-01	Sample Identification, Labeling, Documentation, and Packing for Transport
SAS-03-02	Chain of Custody
SAS-03-03	Sample Location Identification and Control
SAS-04 Series	**SAMPLING QUALITY CONTROL**
SAS-04-01	Data Quality General Considerations
SAS-04-02	Data Quality Objectives
SAS-04-03	Quality Control Samples
SAS-04-04	Equipment Decontamination
SAS-05 Series	**SUBSURFACE INVESTIGATION METHODS**
SAS-05-01	Subsurface Exploration Clearance
SAS-05-02	Field Logging and Classification of Soil and Rocks
SAS-05-03	Well Installation
SAS-05-04	Well Development
SAS-05-05	Borehole and Well Abandonment
SAS-05-06	Test Pit Excavation, Logging, and Sample Collection
SAS-05-07	Test Pit Backfilling and Compaction

SAS-06 Series ..... SOIL SAMPLING AND MEASUREMENT PROCEDURES

SAS-06-01 ..... Soil Sampling for Chemical Analyses and Geotechnical Testing

SAS-06-02 ..... Soil Sampling for Microorganisms

SAS-07 Series SEDIMENT SAMPLING AND MEASUREMENT PROCEDURES

SAS-07-01 ..... Sediment Thickness Determination

SAS-07-02 ..... Description and Classification of Sediments

SAS-07-03 ..... Sediment Sampling

SAS-08 Series GROUNDWATER SAMPLING AND MEASUREMENT PROCEDURES

SAS-08-01 ..... Groundwater and Non-Aqueous Phase Liquid Measurement

SAS-08-02 ..... Low-Flow Groundwater Sampling

SAS-08-03 ..... Well-Volume Approach Groundwater Sampling

SAS-08-04 ..... Aquifer Testing

SAS-08-05 ..... Well Integrity Inspection, Maintenance, and Rehabilitation

SAS-08-06 ..... Potable Water Well Sampling

SAS-08-07 ..... Non-Aqueous Phase Liquid Sampling

SAS-09 Series SURFACE WATER SAMPLING AND MEASUREMENT PROCEDURES

SAS-09-01 ..... Surface Water Sampling for Chemical and Biological Analysis

SAS-09-02 ..... Streamflow Measurement

SAS-10 Series *WITHHELD Not Relevant to Study Activities*

SAS-11 Series SOIL VAPOR SAMPLING AND MEASUREMENT PROCEDURES

SAS-11-01 ..... Sub-Slab Sample Port Installation, Sampling, and Abandonment

SAS-11-02 ..... Post-Run Tubing System Sampling

SAS-11-03 ..... Installation of Probes/Wells for SVE System Effectiveness and Vapor Migration Monitoring

SAS-11-04 ..... SVE System Effectiveness and Vapor Migration Monitoring

SAS-11-05 ..... Field Screening for Fixed Gases and Soil Vapor Concentrations

SAS-11-06 ..... Soil Gas Sampling

SOP SERIES SAS-01
FILE AND DATA MANAGEMENT

STANDARD OPERATING PROCEDURE NO. SAS-01-01

FIELD ACTIVITY DOCUMENTATION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes procedures for documenting field activities and guidance on types and specificity of data to be recorded. Procedures are included for documentation on field logbooks, field forms, and/or field electronic data recorders. This standard is also applicable to photographic documentation collected to support field observations of site conditions and field data entries.

2.0 EQUIPMENT AND MATERIALS

- Field logbooks;
- Field forms;
- Camera and/or camcorder; and
- Waterproof pens with non-erasable ink.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 FORMAT

4.1 FIELD LOGBOOK

Field logbooks shall be bound books that are permanently assigned to a specific project. The cover of each logbook will provide the following identifying information:

- Name of project/site;
- Project number; and
- Book number.

The consultant's contact person(s), address and phone number should be recorded on the inside cover of the field logbook. Only field logbooks with pre-numbered pages shall be used and no pages shall be removed from the logbook.

4.2 Field Forms

Field recording forms are also used for data collection in a variety of activities. The forms include logs for boreholes, well construction, well sampling, etc. It is not necessary to duplicate information recorded on field forms into the field logbooks.

5.0 ENTRIES

5.1 Daily Entries

At the beginning of each daily entry, the following information is recorded:

- Date;
- Time of arrival at the site;
- Weather conditions;
- Physical/environmental conditions at the field site;
- Field personnel present and their responsibilities;
- Level of personal protection if other than Level D; and
- Signature of the person making the entry.

For investigation activities, the entry for each day will contain a complete record of the day's activities including, but not limited to, the following information, unless the data is recorded on field forms.

- Names and titles of site visitors;
- Information concerning sampling changes, scheduling modifications and change orders.
- Location, description and log of photographs of sampling points;
- Description of reference points for maps and photographs of sampling site;
- Field observations;
- Field measurements;
- Equipment calibration and maintenance;
- Sample identification numbers;
- Name of laboratory and overnight delivery service provider or name of laboratory courier and time of sample pick-up;
- Sample documentation, such as chain-of-custody form numbers and shipment air bill numbers;
- Decontamination procedures used;
- Documentation for investigation-derived wastes, such as contents and approximate waste volume in each drum, and number of drums generated;
- Time of departure from the site; and
- Signature of person responsible for observations and date.

Field logbooks are also used as a daily record for remediation activities. General entries similar to the ones listed above are used in remediation activity logbooks. In addition, daily entries regarding excavation activities, waste disposal quantities and methods of transport, system performance data from any remediation systems (e.g. soil vapor extraction systems, recovery well systems, etc.), system or equipment calibration or maintenance performed, and any other pertinent information regarding daily activities.

All logbook entries shall be printed legibly using a pen with waterproof, non-erasable ink. Any lines or pages inadvertently left blank will have a single line drawn through them with the logging person's initials and date written on the line.

When a field log form is used to record field data, all form fields will be completed in full on a daily basis. If a specific data entry area is not applicable, it will be clearly marked as such with the use of "NA" or a dashed

line drawn through it. A single line will be drawn through any unused data entry areas on the form with the field person's signature on the line.

5.2 Entry Changes

Entry changes should be avoided by carefully entering data in the logbook. If a change is required, it should be made by drawing a single line through the original entry such that the original entry is not obscured and entering the correct information next to the original entry. The change in entry will be initialed and dated by the logger. Only the person making the entry may change it.

If there is a change in the person recording field notes during a particular day, that person shall be identified in the logbook prior to making entries. The new logger shall sign and date the logbook at the beginning and end of his entry.

6.0 FORM AND LOGBOOK MANAGEMENT

Site-specific field logbooks and forms will be kept in the in-office project file when not in use. If forms or logbooks are used in the field for an extended period of time, copies of used pages will be made, delivered to the office, and filed in the project file on a periodic basis.

7.0 PHOTOGRAPHIC AND VIDEO RECORDS

7.1 Photographic Record

Photographs shall be taken in the field on a daily basis to document field activities. Field log entries for each photograph may include:

- Photographer’s name;
- Project name and project number;
- Roll and frame number, or digital photograph number;
- Date and time;
- Description of photograph including sampling point, sample name, depth and other relevant identifying information, such as direction faced (e.g. “looking south”) and relationship of photograph to site features.

Photograph prints and negatives will be stored in the project file. Digital photographs will be stored in the electronic project file. If digital photographs are downloaded from the camera in the field, they will be transferred to the in-office electronic file on a regular basis. Photographic prints or paper copies of digital images will be identified with recorded field book entry information.

7.2 Video

Video site recordings will be logged in the field logbook with the following information:

- Recorder's name;
- Project name and project number;
- Date and time;
- Description of subject of video including identification of any persons appearing in video.

If video does not have accompanying audio, record a placard of the site name, date and time and subject of video at the beginning of the video. If the video recorder has an audio recording feature, a narration of the video identifying information may be used. The video tape or digital video disk (DVD) will be labeled with the project name, project number, date, location, and subject). The original, unaltered tape shall be placed in the official files.

8.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, D0420-98R03 Guide to Site Characterization for Engineering Design and Construction Purposes.

ASTM International, D4840-99R04 Guide for Sample Chain-of-Custody Procedures.

ASTM International, D5434-03 Guide for Field Logging of Subsurface Explorations of Soil and Rock.

ASTM International, D6089-97R03E01 Guide for Documenting a Ground-Water Sampling Event.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia, www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-01-02

PROJECT FILE MANAGEMENT Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines to assure the integrity and preservation of electronic files within the Network. It also describes the manner in which electronic files are to be identified and handled in the routine entry of data, reports, proposals, etc. onto computer hard drives and tapes.

2.0 EQUIPMENT AND MATERIALS

- Project files including, but not limited to, documents, data, photographs, correspondence and maps.
- Appropriate paper document storage supplies, furniture and facilities.
- Permanent electronic file storage equipment (computer hard drives and random access memory computer disks [CD-ROMs]).

3.0 FILE SECURITY

Adequate security will be maintained for both paper and electronic files relating to each project in accordance with its corporate document security policies.

4.0 PAPER FILES

4.1 ACTIVE PROJECTS

Paper files containing documents relating to an active project will be maintained at the consultant's office. All paper files will be sorted according to type and filed in accordance with the consultant's internal project-specific paper filing system. Paper documents from field activities will be brought

from the field to the consultant's office for filing on a regular basis. All paper documents will be maintained in the active project files until final closure of the project.

4.2 CLOSED PROJECTS

Upon final closure of the project, all paper files containing documents relating to the project will be permanently archived in accordance with the consultant's internal file retention policies and client-specified file retention or archiving requirements. Discuss these procedures with the Project Manager.

5.0 ELECTRONIC FILES

5.1 ACTIVE PROJECTS

Electronic files containing documents relating to active project will be maintained at the consultant's office. All electronic files will be sorted according to type and filed in accordance with the consultant's internal electronic project filing system. Data saved electronically to field computers will be transferred to the consultant's in-office computer network on a regular basis via CD-ROMs or as attachments to electronic mail (email) transmissions. All electronic documents will be maintained in the active project files until final closure of the project.

5.2 CLOSED PROJECTS

Upon final closure of the project, all electronic files containing documents relating to the project will be permanently archived in accordance with the consultant's internal file retention policies and client-specified file retention or archiving requirements.

5.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

SOP SERIES SAS-02

FIELD MEASUREMENTS - GENERAL

STANDARD OPERATING PROCEDURE NO. SAS-02-01

EQUIPMENT CALIBRATION, OPERATION, AND MAINTENANCE Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for controls, calibration, and maintenance of measurement and testing equipment to be used for obtaining samples for chemical analyses, for measuring field parameters, and for testing various parameter/characteristics. The purpose of this SOP is to ensure the validity of field measurement data generated during field activities as required in the Work Plan or as otherwise specified.

2.0 EQUIPMENT AND MATERIALS

- Measurement and testing equipment ;
- Equipment/instrumentation-specific operation manuals;
- Equipment/instrumentation-specific cases, battery chargers, and attachments; and
- Calibration standards (e.g. standard gas(es), calibration fluids, pH standards, etc.).

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

4.1 General

Field measurements are used to verify sampling procedures, assist in sample selection, and evaluate field conditions. A variety of equipment/instrumentation may be utilized to obtain the field measurements required to satisfy and document project goals outlined in Work Plans or otherwise specified. Therefore, instrument operators must be thoroughly familiar with the operation of measuring instruments. Users will complete the appropriate training and be certified, if required, before using the instrument in the field.

All equipment/instrumentation will be uniquely and permanently identified (model/serial number, equipment inventory number, etc.). Manufacturer's guides/operation manuals will be kept with the instrument or a designated area on the Site, as appropriate. The Site Manager or designee will obtain, identify, and control all equipment/instrumentation to be used during the project.

4.2 Calibration

Measuring equipment/instrumentation must be calibrated before initial use as recommended in the manufacturer's guide/operation manual. Equipment/instrumentation shall be re-calibrated following 1) the manufacturer's recommended calibration frequency, 2) long periods between uses, 3) readings observed above or below the range of the instrument, and/or 4) signs or evidence of equipment malfunction. Daily calibration and re-calibration activities will be recorded in the field logbook and/or on the appropriate field form and will include the following information:

- Date and time of calibration or re-calibration;
- Equipment/instrumentation manufacturer, make, and model;
- Equipment/instrumentation serial or unique inventory number;
- Method of calibration (may reference procedures outlined in the guide/instrument manual);
- Calibration standard(s) used; and
- Deviations, if any, from the manufacturer's recommended procedure(s) or calibration frequency.

4.3 Operation

Manufacturer's instructions will be followed for correct method(s) of operation. Equipment malfunctions and deviations, if any, from the manufacturer's recommended method(s) of operation will be documented in the field logbook and/or on the appropriate field form. Readings obtained from each instrument shall be recorded in the field logbook or on the appropriate field form.

4.4 Maintenance

Equipment/instrumentation will be maintained in accordance with the manufacturer's recommendations. Equipment/instrumentation that malfunctions or is scheduled for routine maintenance will be clearly labeled to prevent its continued use until repairs/maintenance is completed. The Site Manager or her/his designee will be responsible for ensuring that malfunctioning equipment is identified, marked for repair, repaired either in-house or by an outside company in accordance with manufacturer guidelines, checked following repair, and returned to service. The Site Manager or her/his designee will maintain an equipment log, which contains the following:

- Equipment/instrumentation manufacturer, make, and model;
- Equipment/instrumentation serial or unique inventory number;
- Recommended calibration frequency;
- Recommended maintenance frequency, as appropriate;
- Status (in service, not in use, or out of service for repair/maintenance);
- Dates of status changes (e.g. date returned to service); and
- Inspection and maintenance/repair dates.

5.0 REFERENCE

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001

STANDARD OPERATING PROCEDURE NO. SAS-02-02

SURVEYING Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for surveying activities that will be performed by the consultant. Timeframes or budgets may not always allow for surveying by licensed surveying professionals. The consultant may need to obtain information in a timely and cost effective manner that will aid in project decisions (e.g. groundwater flow direction, hydraulic gradient, etc.). In these cases, the consultant will perform basic surveying to obtain this information. The purpose of this SOP is to outline general procedures to obtain reliable surveying data in support of project goals and decisions as required in the Work Plan or as otherwise specified.

2.0 EQUIPMENT AND MATERIALS

- Topcon Auto Level or equivalent;
- Tripod;
- Plumb line;
- Graduated surveying stick; and
- Field logbook and/or appropriate field form.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement

and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

4.1 General

Survey equipment shall be inspected prior to commence of surveying activities to ensure that all components are present and functional. Graduations on the surveying stick should be well marked. Equipment not in satisfactory condition should be removed from service and repaired or replaced, as appropriate.

Operators must be thoroughly familiar with the operation of surveying equipment. Operators should complete the appropriate training and be certified, if required, before using the equipment in the field.

4.2 Benchmark Selection

A fixed, permanent reference point is critical for tying in surveying results to known site features and reproducing surveying results in the field. The benchmark should be a unique location, preferable one that would appear on a plat of survey, that is not likely have its elevation affected by field or outside activities (e.g. flange bolt on a fire hydrant, base of a property boundary stake, corner of a loading dock, etc.). The benchmark shall be documented and clearly described in the field logbook and/or on the appropriate field form. The location of the benchmark should also be measured relative to a minimum of two other permanent site features. These measurements should also be recorded in the field logbook and/or on the appropriate field form. Typically, a licensed surveyor will establish the benchmark which will be used on the site. If the benchmark cannot be established by a licensed surveyor, make sure the Project Manager is informed.

4.3 General Procedures

Surveying will be conducted following the procedures outlined below:

1. Make a table in the field logbook or utilized the appropriate field form to record the following information:
    a. Benchmark;
    b. Assigned benchmark elevation;

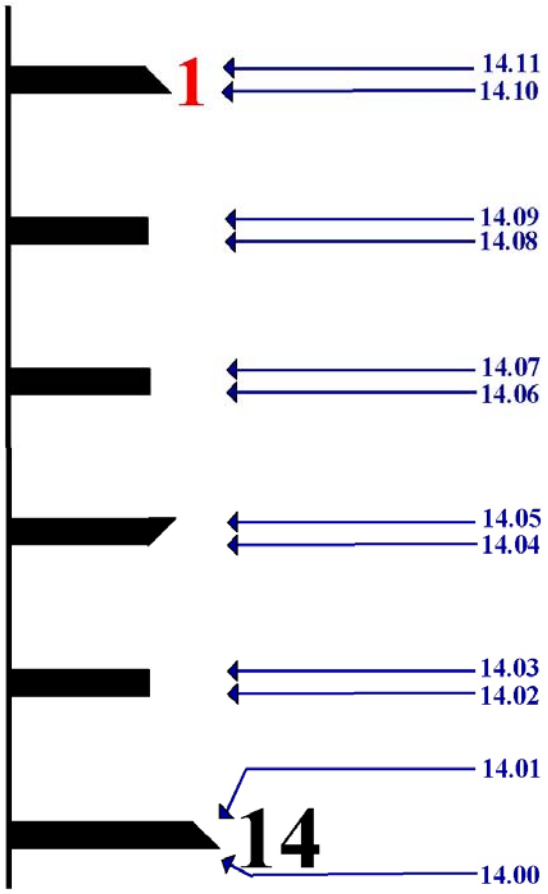
c. Instrument Height(s);
d. Temporary Benchmark(s);
e. Survey points (e.g. monitoring well top of casing, ground surface, etc.); and
f. Surveying stick graduation.

2. Locate a benchmark (BM).
3. Describe the BM in the field logbook and/or on the appropriate field form. The description must be detailed enough to allow a person unfamiliar with the Site to locate the BM.
4. Measure the location of the BM from at least two other permanent site features and record the measurements in the field logbook and/or on the appropriate field form.
5. Choose a location for the tripod that is in view of the benchmark and as many surveying points as possible.
6. Set up the tripod and attach the plumb line.
7. Adjust the tripod legs until the plumb line hangs at a 90-degree angle from the top plate of the tripod.
8. Place the Topcon Auto Level (or equivalent) on the tripod.
9. Adjust the auto level legs until the Topcon Auto Level is level as indicated by the leveling bubble (Note: The bubble should be centered in the circle).
10. Verify the auto level is level by rotating the auto level 90, 180, and 270-degrees. The bubble should be centered in the circle at all three positions. If the bubble is not centered in the circle, repeat Steps 7 through 10.
11. The surveying assistant will stand the surveying stick on the benchmark.
12. The operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level electronically or in the field logbook and/or on the appropriate field form as the back sight measurement.
13. The operator shall record Instrument Height #1 (IH_1), which is obtained by adding the surveying stick graduation to the arbitrary benchmark elevation (usually 100.00 feet), in the field logbook and/or on the appropriate field form.
14. The surveying assistant will stand the surveying stick on a surveying point.

15. The operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level in the field logbook and/or on the appropriate field form as the front sight measurement.
16. The operator shall record Survey Point #1 (SP_1) elevation, which is obtained by subtracting the surveying stick graduation from IH_1, electronically or in the field logbook and/or on the appropriate field form.
17. Repeat Steps 14 through 16 until all survey points or all survey points visible from the first instrument location have been measured.
18. Locate a Temporary Benchmark (TBM_1).
19. The surveying assistant will stand the surveying stick on TBM_1.
20. The operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level in the field logbook and/or on the surveying data form as the front sight measurement.
21. The operator shall record TBM_1 elevation, which is obtained by subtracting the surveying stick graduation from IH_1, electronically or in the field logbook and/or on the appropriate field form.
22. The operator shall relocate the instrument and repeats Steps 6 through 10. Note: During this time the surveying assistant should not remove the surveying stick from the top of TBM_1.
23. Once the instrument has been relocated and leveled, the operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level in the field logbook and/or on the surveying data form as the back sight measurement.
24. The operator shall record Instrument Height #2 (IH_2), which is obtained by adding the surveying stick graduation to the TBM_1 elevation determined in Step 21, electronically or in the field logbook and/or on the appropriate field form.
25. If all surveying points have been measured, skip to Step 36. If all surveying points have not been measured, proceed to step 26.
26. Repeat Steps 14 through 16 until all survey points or all survey points visible from the instrument location have been measured.
27. Locate another Temporary Benchmark ($TBM_{\#}$).
28. The surveying assistant will stand the surveying stick on $TBM_{\#}$.

29. The operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level in the field logbook and/or on the surveying data form as the front sight measurement.
30. The operator shall record $TBM_{\#}$ elevation, which is obtained by subtracting the surveying stick graduation from $IH_{\#}$, electronically or in the field logbook and/or on the appropriate field form.
31. The operator shall relocate the instrument and repeats Steps 6 through 10. Note: During this time the surveying assistant should not remove the surveying stick from the top of $TBM_{\#}$.
32. Once the instrument has been relocated and leveled, the operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level electronically or in the field logbook and/or on the appropriate field form as the back sight measurement.
33. The operator shall record Instrument Height # ($IH_{\#}$), which is obtained by adding the surveying stick graduation to the $TBM_{\#}$ elevation determined in Step 30, electronically or in the field logbook and/or on the appropriate field form.
34. Repeat Steps 14 through 16 until all survey points or all survey points visible from the instrument location have been measured.
35. If all surveying points have been measured, skip to Step 36. If all surveying points have not been measured, proceed to step 27.
36. The surveying assistant will stand the surveying stick on the benchmark.
37. The operator should view the surveying stick through the Topcon Auto Level (or equivalent), read and record the surveying stick graduation that intercepts the center crosshairs of the auto level in the field logbook and/or on the surveying data form as the front sight measurement.
38. The operator record BM elevation, which is obtained by subtracting the surveying stick graduation from $IH_{\#}$, electronically or in the field logbook and/or on the appropriate field form.
39. If the BM elevation is within 02/100 of an inch ($\pm$0.02) of the initial or assigned BM elevation, the surveying has been completed successfully. If the BM elevation is not within 02/100 of an inch ($\pm$ 0.02) of the initial or assigned BM elevation, an error was made or the tripod and/or auto level were bumped during surveying. In this case, the surveying activities were not completed successfully and must be repeated.

4.4 Reading the Surveying Stick



5.0 REFERENCE

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001

SOP SERIES SAS-03

SAMPLE COLLECTION - GENERAL

STANDARD OPERATING PROCEDURE NO. SAS-03-01

SAMPLE IDENTIFICATION, LABELING, DOCUMENTATION AND PACKING FOR TRANSPORT Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes procedures for identifying, logging, packing, preserving and transporting environmental samples for chemical or physical analysis.

2.0 EQUIPMENT AND MATERIALS

- Sample containers;
- Sample labels;
- Field logbook;
- Pens with waterproof, non-erasable ink;
- Chain-of-custody (COC) forms;
- Custody seals
- Clear plastic sealing tape;
- Coolers for transporting samples to the laboratory;
- Ice (if required)
- Gallon-size sealable plastic bags; and
- Air bills or similar transportation provider forms.

3.0 HEALTH AND SAFETY

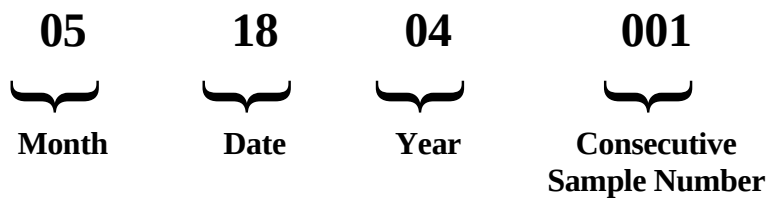
Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from

available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 SAMPLE IDENTIFICATION

A unique 9-digit identification code will be assigned to each sample retained for analysis on all United States Environmental Protection Agency (USEPA) sites and on a site-specific basis as determined by the project manager. This code will be formatted as a number series with the sample month (2-digit), date (2-digit), year (2-digit) and consecutive sample number (3-digit).

Example: The first sample for a particular phase of an investigation collected on May 18, 2004 would be identified as 051804001, as detailed below.



Consecutive sample numbers will indicate the individual sample sequence in the total set of samples collected during that phase of investigation.

Duplicate samples will be assigned a unique 9-digit identification code. Samples selected for matrix spike/matrix spike duplicates (MS/MSD) will include "MS/MSD" at the end of the unique 9-digit identification code. The unique 9-digit identification code is compatible with USEPA electronic data submittal requirements. Sample identification numbers will be used on sample labels, COC forms and other applicable sampling activity documentation.

Sample media codes will be noted on field notes and logs using the following media codes:

Sample numbering will consist of up to three components: a three-character alpha Site identification code; a four- to five-character alpha numeric sample type code; and the sample depth below ground surface (bgs, if soil) or the sample depth below top of mudline (sediment). Groundwater samples will typically not include sample depth bgs unless there are multiple intervals sampled in one open borehole. An example of a completely numbered sample, with each component identified follows.

Example: AES-SP01-(0-0.5)
Where: AES – Any Environmental Site
SP01 – Soil probe location number 1
(0-0.5) – soil sample collected 0-0.5 feet bgs

The site identification code (e.g. AES in the sample above) will remain the same for all samples collected at the Site.

The sample type code (SP01) will vary depending on sample type and location. The following are typical alpha codes to be used in the alphanumeric sample type code for samples:

- AS – air sparging sample;
- CF – confirmation soil sample;
- GP – gas probe sample;
- MW – groundwater monitoring well (if deep and shallow wells are sampled for the same location, this type code is modified to DMW (deep well) and SMW (shallow well);
- PZ – piezometer sample;
- RW – recovery well sample;
- SB – soil boring sample;
- SD – sediment sample;
- SP – soil probe sample;
- SS – surface soil sample;
- SR – source material (used if source material is known to exist);

- SV – soil vapor probe sample;
- SW – surface water sample;
- TP – test pit sample; and
- VE – vapor extraction sample.
- WC – waste characterization (may be preceded by S for solid waste or L for liquid waste).

If additional sampling type codes are required, they will be specified in the site-specific work plan.

When completing soil borings and probes, if a water sample is collected from an open boring or probe location a "w" will be attached to the end of the alpha-numeric sample type code (e.g., SB01W). The numerical portion of the sample type code will indicate the sample location (i.e., boring location 01, 02, 03, etc.).

5.0 SAMPLE LABELING

The following information will be included on each sample label: site name/client, sample number, name of sampler, sample collection date and time, depth of sample (if applicable), analyses or tests requested and preservations added. Information known before field activities (site name, analyses requested, etc.) can be preprinted on sample labels. Duplicate sample labels can be prepared when various sample aliquots must be submitted separately for individual analyses.

6.0 SAMPLE DOCUMENTATION

The following itemized list will be used as a general reference for completion of sample documentation:

- Record all pertinent sample activity in the field logbook in accordance with SOP SAS-01-01, Field Documentation and Reporting.
- Make or obtain a list of samples to be packaged and shipped that day.
- Determine number of coolers required to accommodate the day's shipment based on number of samples to be shipped, number of containers per sample and number of sample containers that will fit in each cooler.
- If samples are shipped by Federal Express or other express shipping service, complete an air bill.

- Assign chain-of-custody form to each cooler and determine which sample containers will be shipped in each cooler. (Note: More than one chain-of-custody form may be needed to accommodate number of samples to be shipped in one cooler).
- Determine which samples will be shipped under each chain-of-custody form. Each day that samples are shipped, record chain-of-custody form numbers, and air bill numbers (if used) in field logbook. Cross-reference air bill and chain-of-custody numbers.
- Complete COC forms in accordance with SOP SAS-03-02, Chain of Custody.
- Assign custody seals to each cooler and temporarily clip seals to each chain-of-custody form.
- Group paperwork associated with each cooler with a separate clip.
- Obtain necessary field team members' full signatures or initials on appropriate paperwork.

7.0 SAMPLE PACKING FOR TRANSPORT

The steps outlined below will be followed to pack the sample containers into coolers for shipment.

1. Each glass sample container will be wrapped with protective packing material.
2. Packing material will be placed in the bottom of each cooler for cushioning.
3. Sample containers will be placed inside each cooler, taking care not to overfill the cooler.
4. Ice will be double bagged sealable plastic bags and added to the cooler on top of the samples. Sample containers will be packed so that they are not in direct contact with ice. The remaining empty space in each cooler will be filled with packing material.
5. Packing material will be placed over the top of the bagged ice.
6. The chain-of-custody records will be signed, and the date and time at which the coolers are sealed for transport by a shipping company, or relinquished to a delivery service or the laboratory sample receiving department will be indicated.
7. Copies of chain-of-custody records will be separated. The original signature copies will be sealed in a large, sealable, plastic bag and taped to the inside lid of a cooler. A copy of each COC will be retained by the Site Manager.
8. If any cooler has a drain, the drain will be taped shut.
9. The lid to each cooler will be closed and latched. Custody seals will be affixed to each cooler between the lid and the body of the cooler. One custody seal will be placed on the front of the cooler, and one will

be placed on the back. Custody seals will be covered with clear plastic tape. An example of a custody seal is located in SOP SAS-03-02, Chain-of-Custody.

10. The cooler will be closed and taped shut on both ends with several revolutions of tape. Also, tape will be wrapped several times around the cooler body and the cooler lid to firmly secure the cooler lid and body together.
11. Samples will be packed and transported to the analytical laboratory within one day of collection.

8.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, D3694-96(2004) Standard Practices for Preparation of Sample Containers and for Preservation of Organic Constituents

ASTM International, D4220-95R00 Practices for Preserving and Transporting Soil Samples

ASTM International, D4840-99(2004) Standard Guide for Sampling Chain-of-Custody Procedures.

ASTM International, D6911-03 Guide for Packaging and Shipping Environmental Samples for Laboratory Analysis

International Air Transport Association (IATA), 2005, Dangerous Goods Regulations.
USEPA, 1981, *Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples*, Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), April 13, 1981.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-03-02

CHAIN OF CUSTODY Revision 0

1.0 PURPOSE

This Standard Operating Procedure describes procedures for preparation and use of the chain of custody (COC) form that accompanies field-collected soil, sediment, water, air or geotechnical samples. Procedures are also provided for preparation and use of custody seals for securing openings of sample containers during transport of samples to the analytical laboratory. COC forms and custody seals are used to provide documentation of sample integrity from the time of collection to time of sample receipt and acceptance by the analyzing laboratory or testing laboratory.

2.0 EQUIPMENT AND MATERIALS

- COC forms;
- Custody seals;
- Gallon-size plastic sealable bags; and
- Clear plastic packing tape.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 METHODS/PROCEDURES

4.1 Chain of Custody Form Items to Complete

Attachment A presents an example COC form. The following general information must be completed on the COC form:

- Laboratory name, address, telephone number;
- Document control number;
- Site manager name on Attention line;
- Project number;
- Site name;
- Complete field sample identification number;
- Sample collection date for soil, sediment and water samples or sample start and collection dates for ambient air monitoring samples;
- Time of sample collection for soil, sediment and water samples or sample start and collection times for air monitoring samples;
- Sample matrix (i.e. liquid, solid, or gas);
- Number of containers;
- Analysis or testing method requested;
- End pressure, Summa can identification number, and flow controller serial number for air monitoring BTEX samples and filter identification number for air monitoring PM10 samples.
- Sample preservatives used (other than ice) in Remarks column;
- Turn-around time requested (specify if turn-around time is business or calendar days) in Special Instructions box;
- Signature of person(s) conducting sampling;
- Strike line with samplers initials and the date samples are relinquished in order to complete unused portion of COC form;
- Signature of person relinquishing the sample custody (person relinquishing custody must be a sampler to ensure chain of custody is maintained);
- Signature of person transporting samples to the lab if other than sampler/relinquisher or third-party carrier;

- **DO NOT** write "FedEx" or other third-party carrier's name in the Relinquished To box. The air bill and carrier's established custody documentation procedure is used to verify custody during transportation.
- Date and time samples are relinquished;
- Custody seal identification numbers; and
- Freight bill identification number in Special Instructions box or at bottom of Remarks column (if third party shipper is used to transport).

4.2 Chain of Custody Form and Procedures

- If a sampling event requires the use of more than one shipping container (cooler for soil/sediment/water samples or box for certain air monitoring samples or soil samples for geotechnical testing) a separate COC form must be completed for each shipping container. For each container, the associated COC form must list only the samples contained in that container.
- When it is known that numerous chains of custody will be required for a project or for a single sampling event, it is acceptable to pre-type the laboratory name, address, telephone number, project number, site name, 3-letter project name abbreviation in Document Control Number area, and site manager name. These are the only information fields that may be pre-typed.
- Each COC should contain a unique document control number in the format: 3-letter project name abbreviation – identification number – 4 digit year, e.g. AES-001-2006, AES-002-2006 and so on. For each project COC identification numbers should be assigned sequentially beginning with 001 for each calendar year. (Exception: for remediation ambient air monitoring projects that span two or more calendar years, continue sequential numbering throughout the project.)
- The COC form must be completed in ink.
- Corrections must be made by drawing a single line through the data that is in error and initialing and dating at the end of the line. The use of correction fluid or tape is not allowed. Do not write over text or numbers to correct. If multiple corrections are needed, copy correct information to a new COC and destroy copy with errors.
- If the number of samples included in the shipping container is less than the number of data entry lines on the COC, draw a single diagonal line running from left down to the lower right hand corner of the field sample data area. The sampler's initials and date must appear along the line.

- Seal the completed COC form in a plastic storage bag. For cooler shipping containers, tape the bag to the inside of the cooler lid prior to sealing the cooler. For box shipping containers, insert the bagged COC form into the box prior to sealing the box.
- If samples are to be shipped by a third party carrier (e.g. Federal Express) the third party carrier does not need to sign the chain of custody. The COC form may be sealed inside the container prior to shipping. If samples are to be hand-delivered to a laboratory by someone other than the sampler/relinquisher (e.g., site construction manager or laboratory courier), the sampler/relinquisher must transfer custody by having the carrier sign in the "Received By" section of the COC form and enter the date and time of transfer. Then seal the COC form inside the container.

4.3 Custody Seal Procedures

A sample custody seal is a strip of adhesive paper used to detect unauthorized tampering with samples prior to receipt by the laboratory. Attachment A presents an example of a completed custody seal. Custody seals are pre-numbered and should be used instead of laboratory custody seals whenever possible.

- A minimum of two custody seals are used per shipping container, one on each long side of the cooler or across each opening of a box. For coolers, one of the custody seals must be placed from the lid to the side of the cooler such that it would be necessary to break the seal in order to open the shipping container. Cover each custody seal with a single piece of clear packing tape wrap it around the perimeter of the cooler. For boxes, place a custody seal across each opening of the box (top and bottom) and cover with a piece of packing tape, making sure tape is secured in such a way that it cannot easily be removed.
- The relinquisher must sign and date each custody seal in ink and include the site identification abbreviation in the custody seal number area.
- Each custody seal has a pre-printed unique six-digit identification number. This number along with the site identification abbreviation must be transferred exactly to the Custody Seal Number box on the COC. The identification number of all custody seals used in conjunction with the COC must be listed on the COC. If a custody seal other than the pre-numbered one, a unique identification number must be printed on the seal and transferred exactly to the Custody Seal Number box on the COC.

5.0 DATA MANAGEMENT AND RECORDS MANAGEMENT

A copy of the COC forms and freight bills used in the above procedure will be transferred to the Project Manager and maintained in the project-specific file as part of the official chain of custody record.

6.0 QUALITY CONTROL AND QUALITY ASSURANCE

- Each COC will be checked for accuracy and completeness (i.e. sample list complete, sample data entered correctly etc.) by another member of the field sampling team before samples are relinquished for transport. In the event the sampler is the sole person on-site, the COC will be checked for accuracy and completeness within 24 hours of the sampling event by a member of the project team.
- Review of the COC forms and freight bills used in the above procedure will be conducted during evaluations of sampling procedures by personnel. The COC forms will also be reviewed as part of the data validation process when the laboratory returns the completed COCs following receipt and analysis of samples.

7.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM, International, 1999, D 4840-99 (2004) Standard Guide for Sample Chain-of-Custody Procedures.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

ATTACHMENT A
EXAMPLE CHAIN-OF-CUSTODY AND CUSTODY SEAL FORMS

Request for Chemical Analysis and Chain of Custody Record

Send Results to:	Laboratory:	Document Control No.:
	Address:	Lab. Reference No. or Episode N
Attention:	City/State/ZIP:	
	Telephone:	
Project Number:		Sample Type
Site Name:		Matrix

Sample Number			Sample Event		Sample Depth (in feet)		Sample Collected		Matrix			Number of Containers	Parameter/Method Code						Remarks
Group or SWMU Name	Sample Point	Sample Designator	Round	Year	From	To	Date	Time	Liquid	Solid	Gas								

Sampler *(Print Name)*:	Sampler *(signature)*:	Custody Seal Number	Special Instructions

Relinquished By *(signature)*: 1.	Date/Time	Received By *(signature)*: 1.	Date/Time	Ice Present in Container: Yes ☐ No ☐	Temperature Upon Receipt:
Relinquished By (signature): 2.	Date/Time	Received By (signature): 2.	Date/Time	Laboratory Comments:	

Signature _____

Date _____ # -112504

STANDARD OPERATING PROCEDURE NO. SAS-03-03

SAMPLE LOCATION IDENTIFICATION AND CONTROL Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the identification of sample locations and field measurements of topographic features, water levels, geophysical parameters, and physical dimensions frequently required during groundwater, hazardous waste, and related field investigation activities. The scope of such measurements depends on the purpose of the field investigation. Samples collected from each sampling location will have a unique sample identified in accordance with ENV-03-01.

All sampling locations shall be uniquely identified and depicted on an accurate drawing or a topographic or other site map, or be referenced in such a manner that their location(s) are established and reproducible. A sample location must be identified by a coordinate system or other appropriate procedures which would enable an independent investigator, to collect samples from reproducible locations. Repetitive sampling might be performed, for example, to monitor the progress of a remedial program, to check for suspected erroneous results from an initial sampling, or to check the reproducibility of results.

2.0 EQUIPMENT AND MATERIALS

- Site map;
- Surveying equipment;
- Measuring tape;
- Field notebooks/logs; and
- GPS unit.

3.0 SAMPLE LOCATION IDENTIFICATION

Locations for collection of samples are assigned alphanumeric codes which are used to coordinate laboratory data tracking and graphic depiction of sample locations on drawings and figures. Samples collected from each sampling location will have a unique sample identified in accordance with ENV-03-01. Each sample location is issued a unique numeric code that corresponds to a specific map location on a plan view of a site and vicinity. An alpha-code (letter) is used to describe the type of sampling activity performed at the specific numeric location. The following alpha codes will be used:

Air	AS	Air Sparging Point
	GP	Gas Probe
	GM	Gas Monitoring Well
	SV	Soil Vapor Probe
	VE	Soil Vapor Extraction Well
Material	AC	Asbestos Containing Material
	LS	Lead Wipe Sample
Sediment	SD	Sediment
Soil	SB	Soil Boring
	SS	Surface Soil
	TP	Test Pit
	EB	Excavation Base
	EW	Excavation Well
Water	MW	Groundwater Monitoring Well
	PZ	Piezometer
	PW	Potable Water Well
	RW	Recovery Well
	TW	Temporary Monitoring Well
	SW	Surface Water
	SG	Surface Water Staff Gauge

A typical series of alpha numeric codes for a site might include test pit locations TP01 through TP12; borings SB01, SB02, SB03; monitoring wells MW01, MW02, MW03, etc.

Each sample location will have only one alphanumeric code. A borehole drilled for the purpose of installing a monitoring well will be identified as MW01. There should not be a location SB01 for soil sample location identification and MW01 for groundwater sample location identification.

Note that soil borings performed for the purpose of collecting a groundwater grab sample (e.g. through screened auger, open borehole, Geoprobe®, Hydro-Punch®, etc.) are identified as soil borings, not monitoring wells. These types of sampling locations may be further identified on site figures with a clarifying suffix (GW), such as SB01(GW). The site map legend will explain the meaning of all symbols used to identify sampling points.

If previous work has been performed at a site, the alphanumeric code should continue with previous successive numbers. If there is any potential for conflict with existing sample number identifiers, the proposed sample number should begin with series 101, 1001, or other appropriate system. Dashes should be eliminated from sample number identifiers, such as SB101 should be used instead of SB-101.

4.0 SURVEYED LOCATIONS

Survey control should be performed following monitoring well and borehole installations by a surveyor licensed in the state of the project site. Vertical elevations to the top of each new well casing will be established within ± 0.01 foot. Ground surface elevations at each well and borehole location should be established within ± 0.01 foot. Elevations should be referenced to the North American Vertical Datum of 1988 (NAVD 88). Alternative systems may be used on a project-specific basis, with appropriate reference documentation in the master project file and final reports.

Lateral locations based on an established grid system will be determined for each sampling location. Lateral locations should be calculated to within ± 1-foot. The site map should include at minimum sampling locations, structure boundaries, property boundaries, nearby surface water, site grid system origin according

to either a state plane coordinate system or latitude and longitude, bar scale, and a north arrow. Specific state reporting and mapping requirements should be checked prior to final plan development.

In conducting vertical surveys, the following procedures should be used or should be referenced in subcontractor service agreements with licensed surveyor:

- When practical, level circuits will close on a bench mark other than starting bench mark;
- Readings should be recorded to the closest 0.01 foot using a calibrated rod;
- Foresight and backsight distances should be reasonably balanced;
- Rod levels should be used;
- No side shot should be used; and
- Benchmarks should be traceable to USGS benchmarks.

Field staff and contractors will record all field data collected during survey activities in accordance with SOP SAS-01-01 for incorporation into site data reports, maps, tables, etc.

5.0 TRIANGULATION

Triangulation shall be used if a registered surveyor is not contracted. This method encompasses distance measurement from sampling points relative to two and sometimes three known points. Distance measurements should be accurate to within ±1 foot allowing for sag in the measuring tape and other inaccuracies. Measuring to two known points is typically adequate for rough measurements made with a pocket transit and 100-foot tape; however, measuring to three known points reduces potential error. Distance measurements should be made relative to distinctive features having a probable life span in excess of 10 years. Examples include the following:

- Power pole located on north side of plant entrance #1 driveway;
- SE corner of plant building 2 located at 111 Survey Circle; or
- NW corner of retaining wall running north-south along Bass Creek.

Unacceptable triangulation points include fence posts, trees, temporary stakes or markers etc., unless these features are to be located within 15 days by survey.

When locating sampling points, decide which site features will be important to illustrate on a site map in the report. If appropriate, also locate areas of known or suspected spills and manholes which may represent migration pathways. Establish relative locations of these and other pertinent site features by triangulation.

The client should be consulted regarding the existence of plant drawings or other surveyed maps which accurately show the relative location of major site features. The field notebook should record information describing the drawing (e.g., who it was prepared by, date, drawing number, etc.) and describe the points on the drawing being used for triangulation purposes.

If only one site feature is convenient for triangulation, the remaining two reference points can be established by running a line toward a more distant site feature, which can be easily located later, and the recorded distance from a defined point along that line.

6.0 GLOBAL POSITIONING SYSTEM (GPS)

Global Positioning System (GPS) is an appropriate method to determine the location of site investigation features in limited circumstances, and is solely at the discretion of the project manager.

There are significant accuracy limitations with GPS which limits the effectiveness of this technology in the role of sample location. For sites where accuracy less than ± 10 feet is acceptable, or surveying is impractical, GPS is a suitable sample location method. GPS is not suitable for sites requiring a higher degree of accuracy. However, the recording of GPS coordinates is encouraged for all sites where monitoring wells or other permanent features may be obscured by snow, vegetation, or other obstructions. In such cases, GPS may assist in locating the monitoring well, etc. despite the accuracy limitations.

7.0 REFERENCES

ASTM International, 2002, D5906-02 Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia, www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

Zilkoski, David B., J.H. Richards, and G.M. Young , 1992, Results of the General Adjustment of the North American Vertical Datum of 1988, American Congress on Surveying and Mapping, Surveying and Land Information Systems, Vol. 52, No. 3, 1992, pp.133-149.

SOP SERIES SAS-04
SAMPLING QUALITY CONTROL

STANDARD OPERATING PROCEDURE NO. SAS-04-01

DATA QUALITY GENERAL CONSIDERATIONS Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes general guidelines that are to be used in conjunction with the USEPA mandatory data quality objectives (DQO) process. Guidelines are intended to assist with planning and conducting quality sampling operations in the field.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials will vary based on the type of data and method of data collection. In general, the following equipment and materials shall be utilized to assist with the collection and recording of quality data:

- Site map(s);
- Field logbook and/or appropriate field forms;
- Method-specific, laboratory-provide containers for the collection of samples for chemical analysis;
- Chain of custody (COC) forms;
- Measuring tape(s), Global Position System (GPS), or other equipment necessary to document sample location; and
- Camera.

3.0 HEALTH AND SAFETY WARNING

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement

and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 SAMPLING CONSIDERATIONS

There are two categories of sampling collection activities. The categories include 1) collection of screening data with definitive confirmation and 2) collection of definitive data. The decision making process in each category incorporates a wide range of analytical methods and provides quality analytical data.

Screening data provides a quick, preliminary assessment of site contamination that involves rapid, non-rigorous methods of sample preparation and less precise analytical methodologies. Preliminary assessments of types and levels of contaminants can be made quickly which allows for the greatest amount of data with the least expenditure of time and money. Screening data generally produces data that can be identified and quantified, but may not be relatively precise. A minimum of 10 percent of the screening data must be confirmed using definitive data. Without sufficient confirmation data, screening data will not be recognized as quality data.

Data that is generated by stringent analytical methods (e.g. approved USEPA methods) is defined as definitive data. Whether generated on or off-site, the quality assurance/quality control (QA/QC) protocol of the analytical methods must be achieved. Analytical and total measurement of error must be calculated for the data to be considered definitive. Definitive data is generally analyte-specific and can be confirmed by subsequent analysis (e.g. duplicate, matrix spike/matrix spike duplicate, etc.). Printed or electronic data, spectra, and chromatographs are typically provided as backup information.

Several factors must be considered prior to data collection to ensure the data obtained meets the DQOs and is appropriately addressed and incorporated into procedures outlined the Site-Specific Work and/or Field Sampling Plan (FSP) or otherwise specified in activity- or task-specific SOPs:

- Representative Sampling Sites – Selection of representative sampling sites is dependent on the type of investigation undertaken.

- Analytical Methods/Parameters – The analytical methods/parameters shall be dictated by the constituents of potential concern (COPCs), sample media, potential range of chemical concentrations, site conditions, and field investigator's knowledge.
- Sample Collection Method – The sample collection method to be used shall be dictated by the investigation, analytical methods/parameters, and category of data desired (screening data with definitive confirmation or definitive data).
- Sampling Equipment – The sampling equipment shall be dictated by the investigation, category of data desired (screening data with definitive confirmation or definitive data), analytical method, sampling method, and the potential for the equipment materials to affect analytical results (e.g. cross-contamination potential, sorption potential, etc.).

5.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2000, D6568 Standard Guide for Planning, Carrying Out, and Reporting Traceable chemical Analyses of Water Samples.

ASTM International, 2004, D7069-04 Guide for Field Quality Assurance in a Ground-water Sampling Event.

USEPA. 1994a. Evaluation of Sampling and Field-Filtration Methods for the Analysis of Trace Metals in Ground Water s. September 1994, EPA/600/SR-94/119.

USEPA, 1995. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria levels. April 1995, EPA/621/R-95/114.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-04-02

DATA QUALITY OBJECTIVES Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for determining Data Quality Objectives (DQOs). The USEPA has established a mandatory DQO process for sites to ensure that all data is scientifically valid. The DQO process also establishes protocols to support decision making which includes defining the type, number, and quality of the environmental data to be collected.

2.0 DATA QUALITY OBJECTIVES PROCESS

The DQO process is a series of seven steps that facilitate the planning of environmental data collection activities. DQOs are qualitative and quantitative statements developed from the DQO process. The DQO process helps investigators ensure that data collected are of the right type, quantity, and quality needed to support environmental decisions.

The following are the seven steps of the DQO process (USEPA 2006):

1. State the problem.
2. Identify the goal of the study.
3. Identify information inputs.
4. Define the boundaries of the study.
5. Develop the analytic approach.
6. Specify performance or acceptance criteria.
7. Develop the plan for obtaining data.

This DQO process shall define qualitative and quantitative criteria for determining when, where, and how many samples (measurements) to collect for a desired level of confidence. The DQO process shall be employed during the planning stages of any field investigation activities that include analytical data collection. This information along with sampling procedures, analytical procedures, and appropriate quality

assurance/quality control (QA/QC) procedures shall be documented in the Quality Assurance Project Plan (QAPP), Field Sampling Plan and SOPs, and/or Site-Specific Work Plan(s).

3.0 DATA QUALITY OBJECTIVE (DQO) LEVELS

Data collected and analyzed from a field investigation is categorized by five DQO levels. Each of these levels is determined by the types of technology and documentation used, and the analytical degree of sophistication. These DQO levels are numbered I through V, with Level I being the lowest quality data and Level V the highest. These DQO levels will be used when determining the appropriate data collection methods for achieving the goals of the field investigation.

3.1 DQO Level I

DQO Level I data typically are field screening data collected in real-time using portable instruments, e.g. photoionization detector (PID). This DQO level is normally used to aid in sample point selection and to differentiate highly impacted samples from low-level impacts. Level I analyses are used for qualitative data collection only, and results cannot be considered quantitative. Instrument calibration provides the quality control component for Level I data.

3.2 DQO Level II

DQO Level II data is typically characterized by field analysis of samples using portable instruments that can be used on-site, e.g. portable gas chromatograph (GC) instrument. This level is considered semi-quantitative due to lack of supporting QA/QC documentation. Instrument calibration provides the quality control component for Level II data.

3.3 DQO Level III

DQO Level III data is data generated in an analytical laboratory using USEPA and other recognized standard methods with rigorous QA/QC protocols. The analytical laboratory can be either an on-site mobile laboratory or a remote laboratory. Level III data is considered quantitative; it provides identification and quantification of chemicals in environmental samples. This data may be used for evaluating compliance of sample results

relative to environmental standards, in risk assessment studies, and may be compared to results of other samples collected at a similar DQO level.

3.4 DQO Level IV

DQO Level IV data is the same as DQO Level III with the addition of rigorous documentation including raw data from the analytical laboratory instruments. Level IV analytical data is quantitative and defensible. Superfund investigations normally require DQO Level IV for data used in conducting formal human health risk assessment studies. Standard USEPA-designated field procedures are required on all investigations requiring DQO Level IV quality data. Any deviations from these methods shall be documented in the field logbook and/or on the appropriate field form, or in the approved Site-Specific Work and/or Sampling Plan. Field personnel involved in data collection shall be aware that such deviations in the fieldwork may reduce the DQO level of the data, with a subsequent reduction in data usability.

3.5 DQO Level V

DQO Level V data include deviations from the standard suites of parameters normally analyzed under the USEPA protocols. DQO Level V procedures are by definition non-standard and, therefore, they are not discussed in detail. DQO Level V procedures generally require pre-approval before use and shall be addressed in Site-Specific Work and/or FSP(s), as appropriate.

4.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, D7069-04 Guide for Field Quality Assurance in a Ground-water Sampling Event.

USEPA, 1990, Quality Assurance/Quality Control Guidance for Removal Activities, Sampling QA/QC Plan and Data Validation Procedures, Interim Final, EPA/540/G-90/004.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, 2002a, Quality Management Plan for the Superfund Division, Region 5, Chicago, Illinois.

USEPA, 2002b, Guidance for Quality Assurance Project Plans, EPA QA/G-5, EPA/240/R-02/009.

USEPA, 2006, Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4, EPA/240/B-06/001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-04-03

QUALITY CONTROL SAMPLES Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the collection of quality control (QC) samples. QC samples are utilized to evaluate field and laboratory quality control procedures and the precision, accuracy, representativeness and comparability of data obtained during investigative activities.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials for the collection and analysis for quality control samples shall be identical to those used for the collection and analysis of the sample of similar media and collection method.

3.0 HEALTH AND SAFETY WARNING

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 QUALITY CONTROL SAMPLES

QC samples include field duplicate samples, matrix spike (MS) and matrix spike duplicate (MSD) samples, trip blanks, and field/equipment blanks.

4.1 Field Duplicate Samples

Duplicate samples are collected from various media to evaluate the representativeness and comparability of data obtained during investigative activities. These samples shall be collected at the same time, using the same procedures, the same equipment, and in the same types of containers as the original sample. They shall also be preserved in the same manner and submitted for the same analyses as the requested analytes. The minimum/required frequency of duplicate sample collection for each sample media shall be specified in the Quality Assurance Project Plan (QAPP), Field Sampling Plan (FSP), and/or Site-Specific Work and/or Sampling Plan(s). If the frequency of collection is in conflict between the above mentioned documents, the Site-Specific Work shall take precedence. The evaluation of these samples is described in the QAPP.

4.2 Matrix Spike and Matrix Spike Duplicate Samples

MS/MSD samples are collected from various media to evaluate the precision and accuracy of laboratory procedures. As with field duplicate samples, MS/MSD samples shall be collected at the same time, using the same procedures, the same equipment, and in the same types of containers as the original sample. They shall also be preserved in the same manner and submitted for the same analyses as the requested analytes. The minimum/required frequency of MS/MSD sample collection for each sample media shall be specified in the QAPP, FSP, and/or Site-Specific Work and/or Sampling Plan(s). If the frequency of collection is in conflict between the above mentioned documents, the Site-Specific Work shall take precedence. The evaluation of these samples is described in the (QAPP).

4.3 Trip Blanks

Trip blanks are used as control or external quality assurance/quality control (QA/QC) samples to detect contamination that may be introduced in the field, in transit to or from the sampling site, or in bottle preparation, sample log-in, or sample storage sites within the laboratory. Trip blanks will also reflect contamination that may occur during the analytical process. Trip blanks are samples of reagent free water, properly preserved, which are prepared in a controlled environment prior to field mobilization. These samples are prepared by the analytical laboratory. The trip blanks are kept with the laboratory provided containers through the sampling process and returned to the laboratory with the other aqueous samples for VOC analysis. Trip blanks must be used for samples intended for VOC analysis and are preserved and analyzed for

VOCs only. One trip blank will accompany each cooler containing aqueous samples for VOC analysis or as specified in the QAPP, FSP, and/or Site-Specific Work and/or Sampling Plan(s). If the frequency of collection is in conflict between the above mentioned documents, the Site-Specific Work shall take precedence. The evaluation of these samples is described in the QAPP.

4.4 Field/Equipment Blanks

Field/equipment blanks are used to determine 1) if non-disposable equipment decontamination procedures are being carried out properly and there is no "carryover" from one sample to another and 2) ensure that disposable equipment is free of measurable concentrations of constituents of potential concern. Field/equipment blank shall be collected by pouring distilled or ultrapure/DI water onto or into the sampling equipment and direct filling the appropriate sample containers with the DI water from the sampling equipment. Field blank will be handled and treated in the same manner as all samples collected unless noted otherwise below. Field/equipment blanks are always collected after sampling equipment has been decontaminated and may be performed prior to collecting the first sample, after collecting highly impacted samples, and/or at the conclusion of sampling. The minimum/required frequency of field/equipment blanks for each sample media shall be specified in the QAPP, FSP, and/or Site-Specific Work and/or Sampling Plan(s). If the frequency of collection is in conflict between the above-mentioned documents, the Site-Specific Work shall take precedence. The evaluation of these samples is described in the QAPP.

5.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, 1990, Quality Assurance/Quality Control Guidance for Removal Activities, Sampling QA/QC Plan and Data Validation Procedures, Interim Final, EPA/540/G-90/004.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, 2002a, Quality Management Plan for the Superfund Division, Region 5, Chicago, Illinois.

USEPA, 2002b, Guidance for Quality Assurance Project Plans, EPA QA/G-5/ EPA/240/R-02/009.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-04-04

EQUIPMENT DECONTAMINATION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for decontamination of equipment prior to its 1) initial use onsite 2) reuse at another sampling interval or location, and 3) demobilization from Site as specified in the Site-Specific Work Plan or as otherwise specified. Personnel decontamination is described in the site-specific Health and Safety Plan (HASP).

2.0 EQUIPMENT AND MATERIALS

Decontamination equipment and materials may vary based on the size or type of equipment, but generally include the following:

- Decontamination detergents (e.g. Alconox);
- Tap water;
- Deionized, distilled and organic-free water;
- Acid solution (optional);
- Approved cleaning solvent (e.g. isopropanol, hexane, Stoddard) (optional and/or site-specific);
- Metal scrapers;
- Brushes;
- Buckets;
- Steam cleaner or high-pressure, hot water washer;
- Racks, normally metal (not wood) to hold miscellaneous equipment;
- Buckets, 55-gallon drums, or other approved storage containers;
- Plastic sheeting;
- Utility pump (optional);
- Paper towels;
- Personal protective equipment; and

- Logbook and/or appropriate field form.

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific HASP based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

4.1 General Requirements

All expected types and levels of contamination shall be discussed during field activity planning and a decontamination plan sufficiently scoped within the Site-Specific Work Plan. Until proven otherwise, all personnel and equipment exiting the area of potential contamination/work zone will be assumed to be contaminated. Personnel involved in decontamination efforts shall be equipped with the same personal protective equipment as those conducting the field activity until a lower level of risk can be confirmed.

Decontamination procedures may be subject to federal, state, local, and/or the client's regulations. All regulatory requirements shall be satisfied, but the procedures adopted shall be no less rigorous than those presented in this SOP.

Climatic conditions anticipated during decontamination activities may impact the implementation of the procedures describe in this SOP. Special facilities or equipment may be needed to compensate for weather conditions (e.g. temporary, heated structures for winter work). In addition, it may be necessary to establish special work conditions during periods of high heat or cold stress.

4.2 Preparation

4.2.1 Site Selection

The equipment decontamination facility or area shall be located in an area where contaminants can be controlled and at the boundary of a "clean zone" or "cold zone". The location shall also be selected to prevent equipment from being exposed to additional or other contamination. When Site layout and size allow, a formal "contamination reduction zone" or "warm zone" shall be established in which decontamination efforts will be conducted. This area shall be conspicuously marked as "off-limits" to all personnel not involved with the decontamination process.

The equipment decontamination facility or area shall also be located where decontamination fluids and materials can be contained and easily discarded or discharged into controlled areas of waste. This facility or area shall have adequate space for the storage of unused and used storage containers, until such time as they can be relocated or disposed of.

4.2.2 Decontamination Pad

Some Site may have an existing decontamination pad. If a decontamination pad has been previously constructed, it shall be evaluated for logistics capabilities, such as water supply, electrical power, by-product handling capabilities, and cleanliness. An existing decontamination pad shall be used or modified to the extent practical. If a decontamination pad is not present or the existing pad cannot be used or modified for use, a pad consisting of a sturdy base, lined with plastic sheeting of high-density polyethylene with four raised sides and a sump for collection of fluids will be constructed unless otherwise specified by the Site-Specific Work Plan. Some field activities, which consist of hand sampling or other small equipment, may not require a decontamination pad. In these cases, buckets, small wash tubs, or small pools may be sufficient for equipment decontamination.

4.2.3 Water Supply

Large volumes of water, often exceeding 1,000 gallons per day, may be required for decontamination activities, especially for drill rigs and other large equipment. The water used for decontamination must be clean, potable water. In most cases, municipal water supplies are adequate. Private potable water supplies shall be evaluated on a case-by-case basis prior to use.

4.2.4 Cleaning Equipment and Supplies

A portable steam cleaner or high-pressure hot water washer is normally required to clean contaminated heavy machinery (e.g. drill rig, backhoe, etc.) as well as materials and associated tools. Most steam cleaners and washers are commercially available for both portable generators or supplied AC power. Site logistical considerations may dictate the type of equipment required. Typical steam cleaners/washers operated on relatively low water consumption rates (2 to 6 gallons per minute) and can be used in conjunction with other cleaning fluids mixed with the water. High-pressure steam is preferred to high-pressure water because of steam's ability to volatilize organics and to remove oil and grease from equipment. Since units tend to malfunction easily and are susceptible to frequent maintenance and repair (especially under frequent use and freezing conditions), a second or back-up unit should be available onsite or arranged for with a nearby vendor to the extent practical, for longer duration field activities.

Garden sprayers may be used for final rinsing or cleaning. However, these sprayers shall be limited to use with small hand tools and sampling equipment. Since these sprayers tend to malfunction or break down easily, a second or backup sprayer shall be maintained onsite.

Metal scrapers and brushes shall be used to physically remove heavy mud, dust, etc. from equipment prior to and during the equipment rinses. Scrapers and brushes are relatively inexpensive and shall be replaced as necessary to support cleaning activities.

Decontamination solutions may consist of the following:

- Laboratory detergent shall be a standard brand of laboratory detergent such as Alconox® or Liquinox®;
- Nitric acid solution (10 percent) will be made from reagent-grade nitric acid and deionized water;
- Cleaning solvent;
- Potable water;
- Deionized water;
- Distilled water; and
- Organic-free water.

The use of cleaning solvents shall be carefully considered prior to use with respect to safety, handling and disposal, and potential impact to analytical results and the environment.

Potable, deionized, distilled, and organic-free water should contain no heavy metals or other inorganic compounds (i.e., at or above analytical detection limits) as defined by a standard Inductively Coupled Argon Plasma Spectrophotometer (ICP) scan and no pesticides, herbicides, extractable organic compounds, and less than 5 µg/l of purgeable organic compounds as measured by a low-level GC/MS scan. The level of QA/QC required during the project to verify and document the purity of the water and the number of rinsate blanks required to verify and document the effectiveness of decontamination procedures shall be based on data quality and project objectives as specified by the Site-Specific Work and/or Quality Assurance Project Plan (QAPP). The use of non-potable or untreated potable water supply for decontamination is not acceptable.

4.3 Equipment and Vehicle Decontamination Procedures

4.3.1 General Procedures

The following procedures are presented as general guidelines and shall be followed unless otherwise required by the Site-Specific Work Plan or otherwise specified:

1. Physical removal of particles;
2. Steam or water wash with potable water to remove particles;
3. Rinse critical pieces of equipment with an approved cleaning solvent or nitric acid solution (optional and/or site-specific);

4. Steam or water wash with a mixture of detergent and potable water;
5. Steam or water rinse with potable water; and
6. Air dry.

4.3.2 Special Case – Drilling Equipment

During decontamination of drilling equipment and accessories, clean auger flights, drill rods, and drill bits as well as all couplings and threads. Generally, decontamination can be limited to the back portion of the drill rig, drill rig tires, drill rig mast, and parts that come in direct contact with samples or casings or drilling equipment placed into or over the borehole.

Some items of drilling equipment cannot typically be decontaminated. These items include wood materials (e.g. planks), porous hoses, engine filters, etc. These items shall not be removed from site until ready to dispose of in an appropriate manner.

Other drilling equipment that requires extensive decontamination is water or grout pumps. Circulating and flushing with a potable water and detergent solution followed by potable may be sufficient to clean them. However, if high or unknown contaminant concentrations or visible product is known to exist, then disassembly and thorough cleaning of internal parts shall be required before removal of the equipment from the Site.

4.4 Sampling Equipment Decontamination Procedures

4.4.1 General Procedures

Sampling equipment shall be decontaminated prior to its 1) initial use onsite 2) reuse at another sampling interval or location, and 3) demobilization from Site using the following procedure as general guidelines unless otherwise required by the Site-Specific Work Plan or otherwise specified:

1. Physical removal of particles;
2. Rinse with an approved cleaning solvent or nitric acid solution (optional and/or site-specific);
3. Wash and scrub with a detergent and potable water solution;
4. Rinse with potable water;

5. Rinse with high-grade water (deionized, distilled, or organic-free);
6. Air dry; and
7. Wrap in aluminum foil, shiny side out, for transport.

4.4.2 Special Cases

Steel tapes, water and interface probes, transducers, and thermometers, shall be cleaned with a detergent solution and rinsed with high-grade water. Water quality meters shall be rinsed with high-grade water.

Pumps with internal components that contact a water sample (e.g., bladder pump) shall be deconned by pumping a detergent solution (minimum two gallons) followed by potable water rinse (minimum two gallons) and a high-grade water rinse (minimum two gallons). If field conditions (e.g., the presence of product) indicate circulating and flushing a pump with a detergent solution followed by potable water is not an adequate field decontamination procedure, the pump shall be disassembled and internal parts thoroughly cleaned with a detergent solution followed by potable water rinse and a high-grade water rinse.

4.5 Well Material Decontamination Procedures

Well construction materials, including end cap, screen, and riser pipe, whether polyvinyl chloride (PVC), stainless steel, or other material shall be cleaned with a steam cleaner or high-pressure hot water washer before it is installed in the borehole. Well construction materials shall be handled while wearing latex, nitrile, or equivalent gloves.

4.6 Equipment Segregating and Labeling

Decontaminated equipment shall be stored separating from contaminated equipment in a manner that prevents the recontamination of "clean" equipment. Equipment that is cleaned utilizing these procedures shall receive a final decontamination process at the completion of field activities and will be tagged, labeled, or marked with the date that the equipment was cleaned.

4.7 Disposal Practices

4.7.1 General Disposal Requirements

Disposal practices shall be in accordance with the procedures specified in the Site-Specific Work Plan. Decontamination derived waste shall be contained, consolidated, and disposed shall be conducted to prevent the spread of contaminants offsite or to "clean" locations onsite and in a manner consistent with the acceptable disposal practices for the type and concentration of wastes that may be contained in the decontamination derived waste. Contaminated equipment or solutions shall not be discarded in any manner that may lead to the contamination of the environment by the migration of hazardous constituents from the Site by air, surface, or subsurface transport mechanisms.

4.7.2 Onsite Storage, Treatment, and Disposal

On controlled, secured facilities, most decontamination derived waste shall remain onsite pending waste characterization and disposal. The decontamination derived waste shall be labeled and stored in a manner that does not pose a threat to contamination of personnel or areas to be sampled or a threat of release to the environment. Liquids and solids shall be containerized separately in approved storage containers. Each storage container shall be labeled with the following:

- Contents (e.g. decontamination fluids);
- Incompatibilities (if applicable);
- Accumulation date; and
- Contact person and phone number.

In some cases, an onsite treatment system is available for certain types of decontamination derived waste. Treatment of decontaminated derived wastes shall be performed in accordance with any applicable permit requirements and federal, state, and local laws and regulations.

In some cases, certain materials that are not contaminated or contain very low levels of contamination may be disposed of onsite. Such materials may include may include drill cuttings, wash water, drilling fluids, and water removed during the purging or sampling of wells. The low level of contamination (concentrations

below applicable cleanup objectives) shall be confirmed prior to onsite disposal. Onsite disposal shall comply with federal, state, and local laws and regulations.

4.7.3 Offsite Disposal

In most cases, decontamination derived waste cannot be disposed of or treated onsite. Decontaminated derived waste shall be properly characterized prior to shipment to a licensed and approved treatment, storage, and disposal facility. Decontamination fluids discharged to sanitary and/or storm sewers shall be properly permitted prior to discharge. Offsite disposal shall comply with federal, state, and local laws and regulations.

5.0 DOCUMENTATION

Decontamination activities, including deviations for general procedures, shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP ENV-01-01 or as required by the Site-Specific Work.

6.0 REFERENCES

ASTM International, D5088-02 Practices for Decontamination of Field Equipment Used at Waste Sites.

USEPA, Region IV, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

SOP SERIES SAS-05
SUBSURFACE INVESTIGATION METHODS

STANDARD OPERATING PROCEDURE NO. SAS-05-01

SUBSURFACE EXPLORATION CLEARANCE Revision 0

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to ensure intrusive site activities are conducted with the knowledge and approval of property owners, utility providers, and governmental agencies, as appropriate, in a manner that minimizes potential exposure to subsurface hazards and damage to subsurface utilities. Clearance of intrusive activity areas must be obtained from appropriate authorities and site operators. This clearance comes in the form of 1) permission to enter a property, 2) ensuring subsurface conditions will not be encountered that endanger the safety of site personnel, subcontractors, and authorized visitors, and 3) demarcation of subsurface utilities/structures.

2.0 HEALTH AND SAFETY WARNING

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

3.0 SITE ACCESS AND ENTRY

Access to properties subject to activities conducted under the contracted scope of services/work order is the responsibility of the client as set forth in the environmental engineering and consulting services agreement. The client will give reasonable access to client-owned properties for performance of services. If the client

does not own or operate the property, it will secure an access agreement or other authorization for consultant access to the site that will address the terms of access as well as any access restrictions.

Site entrance procedures are as follows:

- The client will be advised of the date and time of site entrance and the purpose of the entrance.
- In addition, if the site is not owned by the client, the owner of the property will be advised of the date and time of site entrance and the purpose of the entrance.
- Entrance to the site shall be through the main gate or other entrance specified by the client or owner.
- If a site contact is present at the site, the consultant will introduce herself/himself and provide the site contact with a business card. The consultant shall also identify other personnel who are or will be on-site and explain their functions.
- The consultant will complete any general sign-in procedures required for site entrance, unless otherwise instructed by the client or property owner.
- If a liability waiver is presented that is not pre-agreed to by the consulting company and the client or owner, the consultant will call her/his Project Manager for instructions.
- If entry is refused, the consultant will leave the site entrance and call her/his Project Manager for instructions.
- The time of site entrance, or refusal of entrance will be included in the field logbook entry for the day.

4.0 SITE CLEARANCE

Site clearance is required prior to commencement of any investigation or remediation activities. Three categories of site clearance are required:

1. Property boundary identification,
2. Utility clearance, and
3. Clearance of any on-site subsurface obstructions, hazards or protected structures identified by the client or property owner.

4.1 Property Boundary Identification

The first step in site clearance is to demarcate the property boundaries. A client- or property owner-provided plat of survey will be used if available. If no current plat of survey is available, the client or property owner may be asked to have a licensed surveyor conduct a survey and mark the property boundaries or the consultant may hire a surveyor to conduct the survey on behalf of the client. All property boundaries should be fully known and marked prior to commencement of any site investigation activities. If an investigation location appears to be outside of the property boundaries that encompass the area to which access has been granted, the Project Manager shall be consulted prior to commencement of any activity at that location.

4.2 Utility Clearance

Written clearance of all underground utilities (private, commercial, and public) must be obtained prior to commencing intrusive site activities (e.g. soil borings, GeoProbe advancement, test pit or trench excavation). Utility clearance is vital for safe operations and provides notification to utility companies of intrusive work being conducted in the vicinity of underground lines and structures. The utility clearance process is initiated by calling a state- or city-specific one-call utility clearance hotline. One-call center information may be obtained by calling "811" or visiting http://www.call811.com/state-specific.aspx. Generally, utility clearance must be requested at least 48 hours in advance of the commencement of intrusive activities. In some states, including Illinois, utility clearance is the responsibility of the contractor performing the intrusive work (e.g. drilling subcontractor or excavation company) rather than the contracting environmental consultant.

Assemble the following information to make the call or provide this information to the subcontractor:

- Name, address and phone number of person making request;
- Type and extent (size of excavation) of work being performed;
- Start date and time of excavation;
- Address, including street, number, city, and county (township range, section and quarter section information may also be required);
- Nearest crossroad; and
- General legal description, if available.

The following table lists the one-call-center contact information for the Midwest.

	One Call System Name	Non-Emergency	Emergency	Website
Illinois (except City of Chicago)	J.U.L.I.E. Joint Utility Locating Information for Excavators	(800) 892-0123	- - -	http://www.illinois1call.com
City of Chicago	DIGGER	(312) 744-7000	- - -	http://www.cityofchicago.org
Indiana	I.U.P.P.S. Indiana Underground Plant Protection Service	(800) 382-5544	- - -	http://www.iupps.org
Iowa	Iowa One Call	(800) 292-8989	(800) 292-8989	http://www.iowaonecall.com
Kansas	Kansas One Call	(800) 344-7233	- - -	http://kansasonecall.com
Michigan	MISS DIG System Inc.	(800) 482-7171	- - -	http://www.missdig.org/MissDig/
Missouri	Missouri One Call System	(800) 344-7483	- - -	http://www.mo1call.com
Wisconsin	DIGGER	(800) 242-8511	(800) 500-9592	http://www.diggershotline.com

Utility location agencies may only mark-out utilities on public right-of-ways adjacent to the property under investigation and sewer and water departments may not be included in the locating services provided by the one-call centers. Request additional information from any utility companies or public utilities departments not included in the one-call locating services. It may be advisable at some properties to hire a private utility locating contractor to do additional on-site clearance prior to commencement of intrusive activities. Consult with the Project Manager about conducting additional locating activities if the information provided by the one-call center is not complete with respect to what is known about possible underground utilities at the site.

Do not proceed with any intrusive activities until all utility clearances and mark-outs have been performed by the locating services or participating utility companies. Do not proceed without verification from the subcontractor that the utility clearance has been performed if it was the subcontractor's responsibility to request the utility locating service. Prior to start of intrusive activities, walk the site and surrounding public right-of-way with the subcontractor locating any utility markers and discuss procedures for avoiding marked utilities during the site investigation. If at any time, a potential hazard exists at a proposed investigation

location that cannot be resolved with available information and utility location markings, contact the Project Manager for instructions.

4.3 On-Site Subsurface Obstructions, Hazards and Protected Structures Clearance

The property owner (client or third party) or a designated representative shall also be contacted prior to commencement of any intrusive activities to obtain additional information regarding on-site subsurface obstructions, hazards or protected structures and clearance to conduct the activities in pre-determined locations on the site. If possible, as part of the investigation planning activities, obtain architectural or engineering drawings of the site that include building layouts and locations of subsurface utilities and structures. Schedule an on-site meeting prior to commencement of activities to review locations of proposed locations for intrusive activities. Request that the owner or his authorized representative mark or flag the locations of any known subsurface obstruction, hazard or structure that must not be damaged. In some cases, it may be appropriate to make a site visit prior to the on-site review meeting to mark out proposed subsurface investigation locations for approval by the owner or his representative. During the review meeting, if verbal approval is given to proceed, make an entry in the field logbook including the date, time and person granting approval along with details of the approval given. Record any refusals of permission to perform intrusive activities in the same manner. Include detailed information regarding the reason for the refusal in the field logbook.

If permission for any proposed intrusive activities is refused by the property owner or his representative, inform the Project Manager. If the investigation location approval meeting is performed on a day scheduled for investigation activity, and any locations are not authorized by the owner or his representative, contact the site manager immediately for instructions. Do not proceed with any intrusive activity in the non-authorized locations unless subsequent approval is forthcoming, and do so only upon receiving approval to proceed from the owner/representative and the site Project Manager. Make a detailed record of the refusal and subsequent resolution in the field logbook.

On vacant or undeveloped sites, or sites located in remote areas, on-site client/owner approval of investigation areas may not be practical. In such situations, prior approval of investigation areas may be obtained from the client or owner by means of a site investigation map that includes investigation locations (boreholes, test pit

or trench locations, monitoring wells, etc.). Site features, boundary lines, and any known subsurface utilities or structures shall also be included on the site investigation map to provide the reviewer with adequate information to determine if any subsurface hazards exist in the vicinity of any of the proposed intrusive activities.

5.0 REFERENCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001

USEPA, Region IV, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Enforcement and Investigations Branch, SESD, Athens, Georgia

STANDARD OPERATING PROCEDURE NO. SAS-05-02

FIELD LOGGING AND CLASSIFICATION OF SOIL AND ROCKS Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for logging and classifying soil samples and rock cores during subsurface explorations as described in the Site-Specific Work Plan, or as otherwise specified, for the purposes of characterizing subsurface geologic conditions at a Site.

2.0 EQUIPMENT AND MATERIALS

General:

- Ruler or tape measure in 0.01-foot increments;
- Field logbook and field boring log forms;
- Pen(s) with waterproof, non-erasable ink;
- Camera;
- 5-gallon bucket and wire or nylon brushes, decontamination water, laboratory grade detergent (Alconox or similar), and paper towels;
- Aluminum foil or roll-plastic; and
- Personnel protective equipment, as appropriate, including nitrile gloves for handling impacted soil samples.

Soil Logging:

- Large sharp stainless-steel knife;
- Slim stainless-steel spatula or carpenter's 5-in-1 tool;
- Color chart;
- Comparative charts; and
- Pocket penetrometer.

Rock Coring and Logging:

- Core box(es);
- Hand lens; and
- Comparative charts.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 GENERAL PROCEDURES

Geologic logging and material classification shall be conducted only by a trained logging technician (e.g. geologist, hydrogeologist, engineer, or environmental scientist). Field data and observations associated with field logging and material classification shall be documented during logging and for all drilling and sampling activities in accordance with SOP ENV-01-01, Field Documentation and Reporting, if not otherwise specified in this SOP. All field drilling activities should be recorded in a field logbook and/or on a field boring log form. In addition, tools and equipment used while logging boreholes shall be decontaminated between boring/probe locations and prior to each sampling event in accordance with the Quality Assurance Project Plan (QAPP).

5.0 LOGGING AND DOCUMENTATION PROCEDURES

The logging technician shall record all pertinent drilling information in the field logbook and/or on the field boring log form (Attachment A). At a minimum, the following technical information with respect to pre-sampling, drilling operations and observations, and sample recovery loss shall be recorded, if applicable:

- Project name and number;
- Location (well or boring/probe number) or other sample station identification, including a rough sketch;
- Name of the logging technician overseeing the drilling operations;
- Drill rig manufacturer and model;
- Drilling company name and city and state of origin;
- Driller and assistant(s) names;
- Drilling method(s) and fluids used to drill the borehole;
- Drilling fluid manufacturer;
- Drilling fluid gain or loss;
- Depth of drilling fluid loss;
- Water source (e.g. fire hydrant, faucet, municipality, etc.);
- Borehole diameter;
- Borehole start time and date;
- Borehole completion time and date;
- Sample type (e.g. split spoon, macrocore, etc.);
- Hammer weight/drop and blow counts;
- Sample recovery/loss and explanation of loss, if known;
- Drilling rates when applicable to lithology classification;
- Description of soil and/or rock classification and lithology;
- Lithologic changes and boundaries;
- Depth to water (first encountered [during drilling] and stabilized [upon completion of drilling]);
- Total borehole depth;
- Evidence of impact (e.g. staining, odors, free-phase product, etc.);
- Well materials, construction, and placement information (e.g. casing type and diameter, screen type and diameter, etc.);
- Sample identifications and depths for chemical and geotechnical samples;
- A description of any tests conducted in the borehole; and
- Problems with the drill rig or drilling process.

When rock coring is performed, the following information shall also be recorded:

- Top and bottom of cored interval;
- Core length;
- Coring rate in minutes per foot;
- Core breakage due to discontinuities (e.g. natural fractures versus coring-induced breaks);
- Total core breakage; and
- Number of breaks per foot.

6.0 SOIL SAMPLE CLASSIFICATION AND DESCRIPTIONS

6.1 Description of Hierarchy

The required order of terms is as follows:

1. Depth measured in tenths of a foot;
2. Soil color;
3. Major soil type (e.g. CLAY). This descriptor can include the secondary soil constituent as a modifier (e.g. silty CLAY);
4. Unified Soils Classification System (USCS) Group Symbol in parentheses (e.g. ML);
5. Evidence of environmental impacts, if encountered (e.g. free-phase product, staining, sheen, etc.);
6. Other soil components of the sample listed with the appropriate percent descriptor (i.e. “with”, “some” or “trace.”);
7. Consistency, relative density or degree of cementation;
8. Moisture and plasticity, if relevant; and
9. Miscellaneous (e.g. condition of sample, deposition, fractures, seams, bedding dip, bedding features, fossils, oxidation, drilling rate data when applicable for sample classification, etc.).

6.2 Color

The color descriptions will be consistent with the Munsell Soil Color Chart, Geological Society of America (GSA) Rock Color Chart, or as required by the Work Plan or otherwise specified. Write the Munsell color name with the Munsell color identification number in parenthesis following the color name. The major color

is listed first with any accessory color(s) thereafter (e.g. clay, yellowish gray (5Y 7/2) with pale green (5G 7/2) mottles). If descriptors are used for other soil components, the color designation follows each descriptor.

6.3 Soil Types

Soil descriptions and classification shall be conducted in accordance with the USCS (ASTM D2488-06). The order and presentation of the primary textural classification terms is as follows:

1. Major soil type (e.g. CLAY). This descriptor can include the secondary soil constituent as a modifier (gravelly, sandy, silty, or clayey). Nouns are unabbreviated (e.g. CLAY); "TOPSOIL" is an adequate single term for the naturally occurring organic soil found at the ground surface. In urban areas, "FILL" is used to denote previously disturbed soil, followed by a description of the major and minor soil components (e.g. "FILL, silty clay with some fine sand"). USCS Group Symbol follows the major soil component in parentheses.
2. Other soil components of the sample are listed in descending order of percentage using adjectives "with", "some" and "trace."
3. Using the Wentworth Scale in Attachment E, add size, sorting or angularity modifiers to granular material descriptions as appropriate.

6.4 Consistency and Relative Density

The relative density of cohesionless soils and the consistency of cohesive soils should be included in visual classifications. Attachments B and C can be used in describing the consistency of cohesive soils and the relative density of cohesionless soils, respectively.

A pocket penetrometer will be used to measure consistency of cohesive soils with the result recorded on the field boring log form. Attachment B includes information for determining soil consistency from penetrometer measurements.

6.4 Moisture Content

Moisture Content – Criteria for describing moisture content of soils are described in Attachment D.

6.5 Miscellaneous Descriptions

1. Structure – Some soils possess structural features (e.g. fissures, slickensides, or lenses) that if present, should be described.
2. Accessories or Inclusions – Elements such as rock fragments, fine roots, or nodules are included in the soil description following all other modifiers for the major components of the soil matrix. Any mineralogical or other significant components should be described, as well as man-made or apparently foreign constituents that indicate the presence and possible source of fill material.
3. Environmental Impacts – If monitoring instruments or visual observations indicate the potential presence of environmental impacts, it will be noted in detail. Additional information for describing specific types of impacts may be found in the Work Plan.

To provide consistency in logging soils, tables with additional guidelines for soil description are included in Attachment E.

7.0 ROCK CLASSIFICATION

7.1 Lithology and Texture

The logging technician should describe the lithology of the rock and its mineral composition. The geological name, such as granite, basalt, or sandstone, usually describes the rock's origin. The stratigraphic unit should be identified and assigned the local geological name, if appropriate. Stratigraphic age or period should be identified, if possible. Modifiers will be included to describe the rock texture, including grain size, sorting, packing, cementation, etc. (e.g. interlocking, cemented, or laminated-foliated).

7.2 Color

The color descriptions will be consistent with the Munsell Soil Color Chart, Geological Society of America (GSA) Rock Color Chart, or as required by the Work Plan or otherwise specified. Write the Munsell color name with the Munsell color identification number in parenthesis following the color name. The major color is listed first with any accessory colors thereafter. If secondary or tertiary descriptors are used, the color designation follows each descriptor.

7.3 Hardness

Terms used to describe hardness are described below. One common method to determine hardness is the Mohs Scale of Hardness, which is defined as follows:

Descriptive Term	Defining Characteristics
Very Hard	• Cannot be scratched with a knife. • Does not leave a groove on the rock surface when scratched.
Hard	• Difficult to scratch with a knife. • Leaves a faint groove with sharp edges.
Medium	• Can be scratched with a knife. • Leaves a well-defined groove with sharp edges.
Soft	• Easily scratched with a knife. • Leaves a deep groove with broken edges.
Very Soft	• Can be scratched with a fingernail.

7.4 Weathering

Terms used to describe weathering are described below (ASTM D 5434-03):

Descriptive Term	Defining Characteristics
Fresh	• Rock is unstained. • May be fractured, but discontinuities are not stained.
Slightly	• Rock is unstained. • Discontinuities show some staining on the surface, but discoloration does not penetrate rock mass.
Moderate	• Discontinuous surfaces are stained. • Discoloration may extend into rock mass along discontinuous surfaces.
High	• Individual rock fragments are thoroughly stained and can be crushed with pressure of a hammer. • Discontinuous surfaces are thoroughly stained and may crumble.
Severe	• Rock appears to consist of gravel-sized fragments in “soil” matrix. • Individual fragments are thoroughly discolored and can be broken with fingers.

7.5 Rock Matrix Descriptions

Grain size is a term that describes the fabric of the rock matrix. It is usually described as fine-grained, medium-grained or coarse-grained. The modified Wentworth scale should be used or as required by the Work Plan or otherwise specified.

A description of bedding (after Ingram, 1954) or fracture joint spacing should be provided according to the following:

Spacing	Bedding	Joints/Fractures
< 1 inch	Very thin	Very close
1 – 4 inches	Thin	Close
4 inches to 1 foot	Medium	Moderately close
1 foot to 4.5 feet	Thick	Wide
> 4.5 feet	Very Thick	Very Wide

Discontinuity descriptors are terms that describe number, depth, and type of natural discontinuities. They also describe density, orientation, staining, planarity, alteration, joint or fractural fillings and structural features.

8.0 ROCK CORE HANDLING

The following guidelines shall be followed for rock core handling:

1. Core samples must be placed into core boxes in the sequence of recovery, with the top of the core in the upper left corner of the box.
2. At the bottom of each core run, spacer blocks must be placed to separate the runs. The spacer should be indelibly labeled with the drilling depth to the bottom of the core run regardless of how much core was actually recovered from the run.
3. Spacer blocks should be placed in the core box and labeled appropriately to indicate zones of core loss, if known. Where core samples are removed for laboratory testing, blocks equal to the core length removed should be placed in the box. Note: If wooden core boxes are used, spacer blocks should be nailed securely in place.

4. The core boxes for each boring should be consecutively numbered from the top of the boring to the bottom.
5. The core boxes containing recovered rock cores should be photographed. One core box should be photographed at a time with the box lid framed in the picture to include information printed on the inside of the lid. Be sure to include a legible scale in the picture. Photographs are taken in the field most easily and efficiently with natural light and while the core is fresh.
6. When transporting a boxed core, the box should be moved only if the lid is closed and secured with tape or nails.

9.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2007, D653-07b Terminology Relating to Soil, Rock, and Contained Fluids.

ASTM International, 1999, D1586-99 Standard Method for Penetration Test and Split-Barrel Sampling of Soils.

ASTM International, 2006, D2488-06 Practice for Description and Identification of Soils (Visual-Manual Procedure).

ASTM International, 2001, D4083-89R01E01 Practice for Description of Frozen Soils (Visual-Manual Procedure).

ASTM International, 2007, D4543-07 Practice for Preparing Rock Core Specimens and Determining Dimensional and Shape Tolerances.

ASTM International, 2002, D5079-02 (2006) Practice for Preserving and Transporting Rock Core Samples.

ASTM International, 2003, D5434-03 Guide for Field Logging of Subsurface Explorations of Soil and Rock.

ASTM International, 2000, D5715-00 (2006) Test Methods for Estimating the Degree of Humification of Peat and Other Organic Soils (Visual/Manual Method).

ASTM International, 2004, D6236-98 (2004) Guide for Coring and Logging Cement- or Lime-Stabilized Soil.

ASTM International, 2004, D7099-04 Terminology Relating to Frozen Soil and Rock.

Johnson, R.B., and J.V. DeGraff, 1988, Principles of Engineering Geology, John Wiley and Sons, New York.

U.S. Army Corps of Engineers, 2001, Engineering Manual EM1110-1-1804 - Engineering and Design - Geotechnical Investigations, January 1.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

Wentworth, C.R., 1922, A scale of grade and class terms for clastic sediments, Journal of Geology, 30: 377-392.

ATTACHMENT A
DRILLING LOG

Drilling Log

	Project Name	Project No.	Boring/Monitoring Well Number
	Site-Specific Coordinates	Ground Elevation	Page 1 of 1
	Total Depth (feet) / Hole Size (inches)	Driller (s)	
Drilling Rig		Drilling Company	
Date / To	Logged By:	Reviewed by:	Approved by:

Elevation (feet)	Depth (feet)	Description	Graphic Log	SAMPLING: Sample Type	Sample Interval	Blow Counts per 0.5'	N Value	Sample Recovery/Length (feet)	Penetro-meter (TSF)	PID Reading (PPM)	Remarks (▽ Depth to water while drilling; ▼ Depth to water after drilling)
	1										
	2										
	3										
	4										
	5										
	6										
	7										
	8										
	9										
	10										
	11										
	12										
	13										

ENVIRONMENTAL LOG COPY OF OSI 2003.GPJ BURNS_MO.GDT 8/30/07

ATTACHMENT B
CONSISTENCY OF COHESIVE SOILS

Author: T. Gilles **Q2R & Approval By:** C. Barry **Q3R & Approval By:** M. Kelley

CONSISTENCY OF COHESIVE SOILS

Consistency	Rule-of-Thumb	Blows Per Foot[1] (N value)[2]	Penetrometer (tons/ft^2)
Very Soft	Core (height = twice diameter) sags under own weight	0 – 1	0.0-0.25
Soft	Can be easily pinched in two between thumb and forefinger	2 – 4	0.26-0.49
Firm (Medium Stiff)	Can be imprinted easily with fingers	5 – 8	0.5-0.99
Stiff	Can be imprinted with considerable pressure from fingers	9 – 15	1.0-1.99
Very Stiff	Barely can be imprinted by pressure from fingers	16 – 30	2.0-3.99
Hard	Cannot be imprinted by fingers	> 30	4.0+

Notes:
1) Blows as measure with a 2-inch outer diameter (OD), 1 3/8-inch inner diameter (ID) sampler driven 1 foot by a 140-pound hammer falling 30 inches. See Standard Methods for Penetration Test and Split-Barrel Sampling of Soils, ASTM D1586-99.
2) N value is the sum of the blows from 6 inches to 12 inches and from 12 inches to 18 inches in the 2-foot sample.

ATTACHMENT C
RELATIVE DENSITY OF COHESIONLESS SOILS

Author: T. Gilles **Q2R & Approval By:** C. Barry **Q3R & Approval By:** M. Kelley

RELATIVE DENSITY OF COHESIONLESS SOILS

Consistency	Rule-of-Thumb	Blows Per Foot (N value)[2]
Very Loose	Easily penetrated with a ½-inch diameter steel rod pushed by hand	0 - 4
Loose	Easily penetrated with a ½-inch diameter steel rod pushed by hand	4 - 10
Medium Dense	Easily penetrated with a ½-inch diameter steel rod driven with a 5-pound hammer	11 - 30
Dense	Penetrated a foot with a ½-inch diameter steel rod driven with a 5-pound hammer	31 - 50
Very Dense	Penetrated only a few inches with a ½-inch diameter steel rod driven with a 5-pound hammer	> 50

Notes:
1) Blows as measure with a 2-inch outer diameter (OD), 1 3/8-inch inner diameter (ID) sampler driven 1 foot by a 140-pound hammer falling 30 inches. See Standard Methods for Penetration Test and Split-Barrel Sampling of Soils, ASTM D1586-99.
2) N value is the sum of the blows from 6 inches to 12 inches and from 12 inches to 18 inches in the 2-foot sample.

ATTACHMENT D
CRITERIA FOR ESTIMATING MOISTURE CONTENT OF SOILS

CRITERIA FOR ESTIMATING MOSITURE CONTENT OF SOILS

Adapted from USACE EM 1110-1-1804 and ASTM D 2488-06

Term	Description of Relative Moisture
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, no visible water
Wet	Fine grained: well above optimum water content Coarse grained: visible free water
Saturated	Water is dripping from sample, usually encountered below water table

ATTACHMENT E
STANDARD SOIL DESCRIPTORS

Author: T. Gilles **Q2R & Approval By:** C. Barry **Q3R & Approval By:** M. Kelley

STANDARD SOIL DESCRIPTORS

Grain Size Terminology		
Soil Type		**Diameter**
Boulders		12-inches or greater
Cobbles		3- to 12 inches
Gravel	Coarse	0.75-inch to 3 inches
	Fine	0.19-inch to 0.75-inch
Sand	Very Coarse	1 mm to 2 mm
	Coarse	0.5 mm to 1 mm
	Medium	0.25 mm to 0.5 mm
	Fine	0.06 mm to 0.25 mm
Silt		0.004 mm to 0.06 mm
Clay		Less than 0.004 mm

Notes:
1) mm = millimeter
2) Based on Wentworth Grain Size Scale for Sediment (Wentworth 1922).
3) This terminology can also be used to describe clast size in rock cores.

Estimated Plasticity for Silt and Clay Content		
Thread Diameter (inches)	**Plasticity Index (PI)**	**Identification**
1/4	0	Silt
1/8	5 – 10	Clayey Silt
1/16	10 – 20	Clay and Silt
1/32	20 – 40	Silty Clay
1/64	40	Clay

Relative Proportions of Components	
Descriptive Term	**Percent**
Trace	1 – 10
Little	11 – 20
Some	21 – 30
And	30 – 50

Adapted from ASTM D2488-06

STANDARD DESCRIPTORS – VISUAL OBSERVATIONS OF NAPL

Descriptive Term	Definition
No Visible Evidence	No visible evidence of oil on soil or sediment sample
Sheen	Any visible sheen in the water on soil or sediment particles or the core
Staining	Visible brown or black staining in soil or sediment; can be visible as mottling or in bands; typically associated with fine-grained soil or sediment
Coating	Visible brown or black oil coating soil or sediment particles; typically associated with coarse-grained soil or sediment such as coarse sand, gravels, and cobbles.
Oil Wetted	Visible brown or black oil wetting the soil or sediment sample; oil appears as a liquid and is not held by soil or sediment grains

STANDARD OPERATING PROCEDURE NO. SAS-05-03

WELL INSTALLATION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the installation of monitoring wells, observation wells, and recovery/injection wells as described in the Site-Specific Work Plan, or as otherwise specified. Monitoring and observations wells are installed to 1) determine depth to groundwater and monitor fluctuations in groundwater elevation, 2) determine and monitor the depth and thickness of free-phase products (if present), 3) obtain groundwater and/or free-phase product samples for laboratory analysis, and 4) facilitate aquifer characterization. Recovery wells are installed to conduct testing and operation of systems for groundwater pumping, free-phase product recovery, and aquifer injection.

2.0 EQUIPMENT AND MATERIALS

Field personnel shall use the well construction equipment and materials required by the Site- Specific Work Plan, or as otherwise specified.

3.0 HEALTH AND SAFTEY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

4.1 General requirements

Well installation procedures should meet regulatory agency requirements. In addition, licensing and/or certification of the driller may be required. A trained supervising technician (e.g. geologist, hydrogeologist, engineer, or environmental scientist) should be present during well installation to document the subsurface stratigraphy and construction details for each well.

The well designs should meet two basic criteria: 1) groundwater and/or other fluids (e.g. free-phase product) must move freely into the well, and 2) vertical migration of surface water or undesired groundwater to the well intake zone must, to the extent possible, be eliminated. In addition to these criteria, factors that influence the location of wells should be considered and include the following:

- Project objectives of the Site-Specific Work Plan;
- Data Quality Objectives outlined in the Quality Assurance Project Plan (QAPP);
- Location of facilities and/or source areas to be monitored;
- Groundwater gradient;
- Location of aboveground and underground utilities and manmade features; and
- Accessibility to desired well location sites.

4.2 Well Installation Materials Selection

Materials used in the construction of wells must remain essentially chemically inert with respect to free-phase products and dissolved contaminants in the groundwater for the duration of the investigation period remedial action.

The most commonly used well construction materials are PVC and stainless steel. PVC is the least expensive and easiest material to use. It is generally believed that PVC does not decompose in contact with groundwater containing low concentrations of organics. Stainless steel is chemically inert, provides greater structural strength, and its use may be advantageous for large-diameter wells or groundwater containing high concentrations of organics or free-phase products. Teflon casing is chemically inert but is very expensive.

Well casing and screen are available in threaded or unthreaded sections and typically in lengths of 5, 10, and 20 feet. Threaded pipe joints may be wrapped with Teflon tape to facilitate joining and to improve the seal. Sections of casing and screen should be assembled onsite to allow inspection immediately before installation. No solvents or adhesive compounds should be used on the threaded PVC or Teflon pipe.

4.3 Well Types and Construction Specifications

4.3.1 Monitoring and Observation Wells

Monitoring and observation wells construction should be performed as outlined in the Site-Specific Work Plan or as otherwise specified. In general, the design of the wells consists of a section of slotted well casing or well screen connected to a riser pipe that extends above the ground surface. Typically, a gravel or sand filter pack is placed in the annular space between the screen and the borehole wall. A 3-foot seal composed of hydrated bentonite pellets/chips is placed on top of the filter pack. The remaining height of annulus is sealed and/or grouted to the surface with a cement, bentonite/cement, or high solid bentonite grout; this annular space will be at least 3-feet in height. A lockable protective casing is constructed over the stick-up portion of the wells. Borehole diameters will be chosen in accordance with state regulations and SSWP specification and will meet the following minimum conditions:

- The diameter of the borehole shall be at least 4 inches greater than the inside diameter of the well casing, unless hollow stem augers are utilized.
- The inside diameter of hollow stem augers should generally be at least 2-¼ inches greater than the inside diameter of the well casing and screen.
- These annular clearances facilitate the placement of the filter pack and grout around the outside of the well screen and casing.

The screens for water table observation wells, typically 10 to 15 feet long, are installed with the center of the screen set at the level of the water table to monitor seasonal fluctuation of the water table. Monitoring screens for wells constructed below the water table, typically 5 feet long, are installed at the chosen monitoring elevation as specified in SSWPs. This SOP discusses stick-up well construction; however, flush-mount well construction may also be used as outlined in the Site-Specific Work Plan or otherwise specified.

4.3.2 Recovery/Injection Wells

Construction specifications for recovery/injection wells can vary based several factors including, but not limited, to 1) the type(s) of recovery/injection to be performed, 2) engineering evaluation objectives, 3) data quality objectives, and 3) site geology. Recovery/injection wells should be constructed as outlined in the Site-Specific Work Plan, or otherwise specified.

4.4 Borehole Advancement

4.4.1 General

Boreholes used to install wells should be drilled with the following objectives:

- To provide geological data on subsurface conditions, namely stratigraphy, occurrence of groundwater, and depth to bedrock;
- To obtain representative disturbed or undisturbed samples for identification and laboratory testing; and
- To install wells.

Prior to drilling, the following steps must be taken:

- Obtain permits from appropriate local, state, and/or federal agencies. If there is a fee for permits, drilling subcontractors usually include this as part of their fee.
- Notify (verbally or in writing) the appropriate local, state, and/or federal authorities, as appropriate, in advance of the date that drilling and installation is scheduled to begin;
- Perform a subsurface utility clearance, as outlined in SOP ENV-05-01, at all planned drilling locations;
- Prepare and implement field health and safety procedures as outlined in the HASP(s); and
- Make provisions for containment, storage, and disposal of all cuttings, drilling fluids, discharge water, and other refuse generated during well installation. Note: Permitting and waste characterization may be necessary prior to disposal activities.

4.4.2 Selection of Drilling Method

Drilling methods should be selected based on the following factors:

- The expected nature of the subsurface materials to be encountered in the boring;

- Site accessibility, considering the size, clearance, and mobility of the drilling equipment;
- Availability of drilling water and the acceptability of drilling fluids (e.g., bentonite based drilling mud) in the well;
- Diameter and depth of the well desired, including consideration of the need to set casing to prevent commingling of different transmissive zones; and
- The nature and effects of contaminants expected during the drilling.

5.0 MONITORING AND OBSERVATION WELL INSTALLATION

5.1 Well Components

Typical well components in general order of placement are as followings:

1. Surface casing (if used);
2. Well casing;
3. Screen(s);
4. Filter pack (gravel or sand pack)
5. Filter pack seal (fine sand; and bentonite seal when grout is placed as the annular seal);
6. Annular seal (bentonite chips or grout);
7. Well head protector casing; and
8. Well head apron and guard posts.

Surface casing, if needed, should be installed during borehole advancement for sealing the ground surface and subsurface transmissive zones not desired to be intercepted by the well from the borehole. Surface casing may also be needed to provide lateral support for loose unconsolidated formations that may slough into or collapse around the borehole during drilling or well installation. Casing may be extended in a telescopic fashion to permit casing through intermittent transmissive zones at greater depths to limit casing size and cost requirements.

The well casing is the primary conduit to the desired borehole interval to be monitored. It serves to seal off other stratigraphic zones from the groundwater inside the well and provides unobstructed access to the well screens. The well casing extends from the top of the well screen to either above or flush with the ground

surface. It is typically a single-walled pipe, flush-threaded, of the smallest diameter to facilitate sampling equipment and to support its own weight during installation.

Screens are perforated or slotted sections of casing typically of the same size and material as the well casing. The purpose of the well screen is to allow water and/or other fluids (i.e., product) to enter the well easily while preventing entry of large amounts of sediment. The slot size of the well screen is usually determined based on selection of the filter pack material. Both are commonly related to the grain size analysis of the formation material. Methods of determining appropriate screen slot size are listed in the EPA Manual of Water Well Construction Practices (USEPA 1976). Typically, 10-slot (0.010 inch slot width) or 20-slot (0.020 inch slot width) screens are used. The length of the screen depends on the sampling objective, water level fluctuations, product thickness, and thickness of the transmissive zone of the formation.

A filter pack consisting of clean silica sand or pea gravel is placed in the annular space extending to at least 2 feet above the top of the screen. Filter pack grain size, sand or pea gravel, is determined based on the well screen slot size selected and the nature of the surrounding native material. The filter pack will stabilize the aquifer formation, minimize the entry of fine-grained material into the screen, permit use of screens with different sizes of slot, and will increase the effective well diameter and water collection zone. A filter pack seal, consisting of at least 2 feet of fine sand, will be placed on top of the filter pack to prevent the intrusion of overlying grout material.

For wells with that utilize grout as an annular space seal, an additional filter pack seal, consisting of bentonite pellets or chips, should be installed above the fine-sand filter pack seal to prevent the intrusion of overlying grout material into the filter pack. The bentonite pellets or chips should be slowly poured from the top of the borehole to prevent bridging. At least 3 feet of bentonite seal should be placed on top of the fine-sand filter-pack seal. If the bentonite seal is above the saturated zone, the bentonite pellets or chips should be hydrated with distilled water before grouting the remaining annular space. The source and volume of water used must be recorded in field notes. The hydrated pellets or chips should be allowed to set for a minimum of 15 minutes. Bentonite chips are preferred over pellets or balls when the seal is below the water table because the chips hydrate less rapidly and bridging is less common.

The annular space above the bentonite seal should be grouted with cement high-solids bentonite, bentonite/cement grout, or bentonite chips, up to 30 inches below the ground surface and shall be at least 2 feet in thickness. The primary purpose of grouting is to minimize the vertical migration of water to the groundwater intake zone and to increase the integrity of the well casing.

A 30 inch concrete plug should be installed above the annular grout, when the surface seal is less than 5-feet in depth. The concrete plug is used to set the protective well cover and to prevent frost heave of the concrete pad or apron. The concrete apron should be at least 3.5 inches thick, and it should be sloped to allow water drainage away from the well.

A protective cover with a locking cap should be installed after the well has been set. This cover will protect the exposed well casing from damage and will provide security against tampering with the well. The protective cover typically consists of a steel pipe or box around the well casing. The protective cover is set at least 5 feet into the surface seal and may be reduce to 2 feet if a flush-mount well cover is placed or a shorter protective cover is required to ensure well construction space for a 2 foot minimum annular space seal.. Weep holes (approximately ¼-inch diameter) may be drilled into the base of the protective cover above the concrete apron to allow drainage. Alternatively, one to two inches of fine-grained sand may be placed at the base of the flush-mounted protective cover to facilitate drainage.

Well-head aprons and guard posts, when used, provide additional surface protection to the well and are generally used for wells in high traffic areas or where a more permanent structure is desired.

5.2 Installation Procedures

The decision to install a well at a particular location is often decided in the field upon completion of the boring and subsurface sampling. If the borehole diameter is not sufficient to install a well, either the borehole should be reamed using a larger diameter auger or a new borehole should be drilled. The new borehole should be at least 5 feet away from the initial boring. The initial soil boring should be abandoned according to the procedures outlined in SOP ENV-05-05. If a well is not installed, the boring should be abandoned in accordance with SOP ENV-05-05.

Over-drilling generally should not be conducted to provide room for a well sump or additional filter pack material at the bottom of the borehole beneath the well casing. However, for wash rotary boreholes drilled in soft or highly plastic sediments, loose cuttings may fall to the borehole bottom after backwashing. In this case, it may be necessary to install a 2-foot layer of sand or gravel at the bottom of the boring to provide a firm base on which to set the well assembly to limit settling of the well casing and screen under its own weight.

For mud rotary boreholes, excess drilling fluids should be flushed from the borehole before installing the filter pack and grout seal. This can be accomplished by one or both of the following means:

- Flush the well using the drilling equipment by pumping clean water down the drill pipe without circulating the returned fluid. This should be accomplished at low pump pressure and with care to avoid scouring or fracturing of the formations. The source and volume of water added to the well must be recorded in field notes.
- Insert casing and screens with a backwash valve on the bottom end, and then flush the borehole via the well casing at low pressures. The backwash valve not only provides an outlet for flushing, but also provides pressure relief so the screens are not damaged by the backwash fluid pressures.

The latter method should be conducted only if it is determined that the former is not possible, or if the drilling fluid must remain in place in order to install the filter pack.

Connect the screen and well casing while wearing latex gloves. Insert and lower the screen and well casing into the borehole in 10-foot increments. Hand-tighten connections to prevent them from leaking or becoming loose. The final section of pipe should be measured and field cut, if necessary, before connecting to allow for a stick-up of at least 2 feet. The cut end should be rasped and/or sanded smooth, taking care not to let fillings of casing material cling to the inside.

Backwash the boring, if necessary, and pour in sand or gravel to seat and support the casing and screen. Based on boring and casing diameters, determine volume of filter pack material required to place the filter approximately 2 feet above the top of the screens. Install filter pack using the following methods, as appropriate.

- Slowly pour filter material down annulus, being careful to evenly distribute the material around the casing and to avoid the material becoming packed between the sidewall and casing. Use a small-diameter pipe to dislodge packed material and to ensure adequate height and settlement of the filter pack.

- Pour filter material down tremie pipe placed between boring sidewall and casing. In this method, clean potable or distilled water should be poured in along with the sand or gravel to prevent packing within the tremie. The source and volume of water added must be recorded in field notes. The bottom of the tremie should be kept above the filter material top by at least 5 feet to permit the filter material to evenly fall around the screens. Pack the material with the tremie pipe to ensure adequate height and settlement of the filter pack.

Pour bentonite pellets or chips down the annulus on top of the filter pack. The bentonite should be placed rapidly to prevent swelling and bridging around the casing when it hydrates. The bentonite should be allowed to hydrate for at least 15 minutes before grouting.

The remaining annulus should be sealed by pumping grout via a tremie pipe from the bottom of the annular space of the borehole until the grout returns to the surface displacing all remaining drilling fluid and formation water. The bottom of the tremie pipe should not be placed within 4 feet of the bentonite seal. Grouting mixture and technique should be in accordance with Site-Specific Work Plan requirements, or as otherwise specified. Grout will typically settle 1 to 2 feet. Remove excess grout to allow 30 inches of annular space for the concrete plug or native material.

After the grout has stiffened sufficiently, install the concrete plug up to the ground surface. Set the protective cover, if possible, such that at least 2 feet of its length is embedded in the concrete below the ground surface. It should also be set such that it is not more than approximately 30 to 36 inches above the level where the sampling personnel must stand. A concrete pad approximately 3 feet in diameter and 3.5 inches thick should be formed around the base of the protective cover. The concrete pad should be sloped away from the protective cover to allow flow away from the well. Weep holes should be drilled through the protective cover nominally 1 inch above the top of the concrete apron.

The protective casing should be marked with identifying decals. A locking device should be installed to prevent unauthorized entry or vandalism of the well. The top of the well casing should be notched with a file to provide a reference point in which to measure water and/or product levels. The elevation of the top of the well casing (reference point) and ground surface at the well should be surveyed relative to a benchmark. The location of the well should also be surveyed in reference to the site coordinate system as required by the Site-Specific Work Plan, or as otherwise specified.

Develop well within 24 to 72 hours following well installation according to the well development procedures outlined in ENV-05-04.

6.0 DOCUMENTATION

Documentation of well installation should be the responsibility of the supervising field technician. A well completion report should be prepared after the well is installed. The Illinois Department of Public Health Well Completion Report is provided as a well completion report example in Attachment A. If the work is performed in a different state, the relevant forms must be obtained.

The drilling and well installation activities should be recorded in the field logbook and/or on the appropriate field forms. The following information should be recorded during and upon completions of every well installation:

- Project name and number;
- Well location identification;
- Date of installation and time completed;
- Drilling method, crew names, and rig identification;
- Drilling depths;
- Generalized subsurface stratigraphy;
- Total length of casing and screens;
- Depth to and length of screened intervals;
- Depth to top of filter pack;

- Depth to top of bentonite seal;
- Depth to top of grout;
- Depth of surface casing (if applicable);
- Elevation of top of well casing and ground surface; and
- Name of supervising field technician.

The driller should also prepare any state-required well completion forms in accordance with state regulatory requirements.

7.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2004, D5092-04 Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers.

ASTM International, 2005, D6001-05 Guide for Direct-Push Ground Water Sampling for Environmental Site Characterization.

ASTM International, 2004, D6724-04 Guide for Installation of Direct-Push Ground Water Monitoring Wells.

ASTM International, 2004, D67-25-04 Practice for Direct-Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers.

USEPA, 1976, Manual of Water Well Construction Practices, EPA/570/9-75/001.

USEPA, 2002, Ecological Assessment Standard Operating Procedures and Quality Assurance Manual, SESD, Region 4, Ecological Assessment Branch, Athens, Georgia.

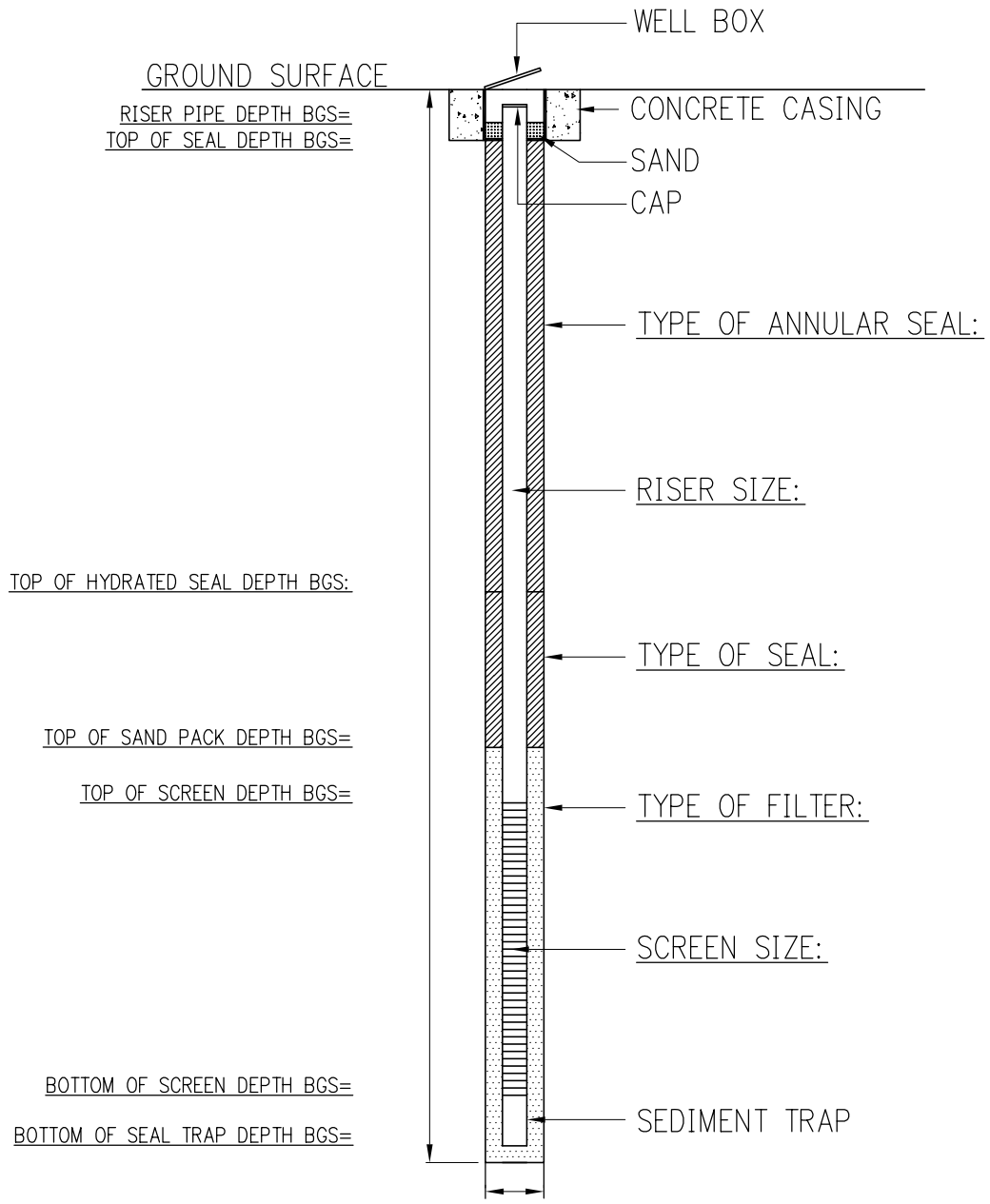
USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

ATTACHMENT A
WELL INSTALLATION LOGS

WELL INSTALLATION LOG

No. _____

CLIENT	COORDINATES N E	PROJECT	PROJECT NO.
PROJECT LOCATION		TOP OF RISER ELEVATION (DATUM)	DATE
STRATUM MONITORED		LOGGED BY	
DRILLING COMPANY		APPROVED BY	



NOT TO SCALE

METHOD OF INSTALLATION:

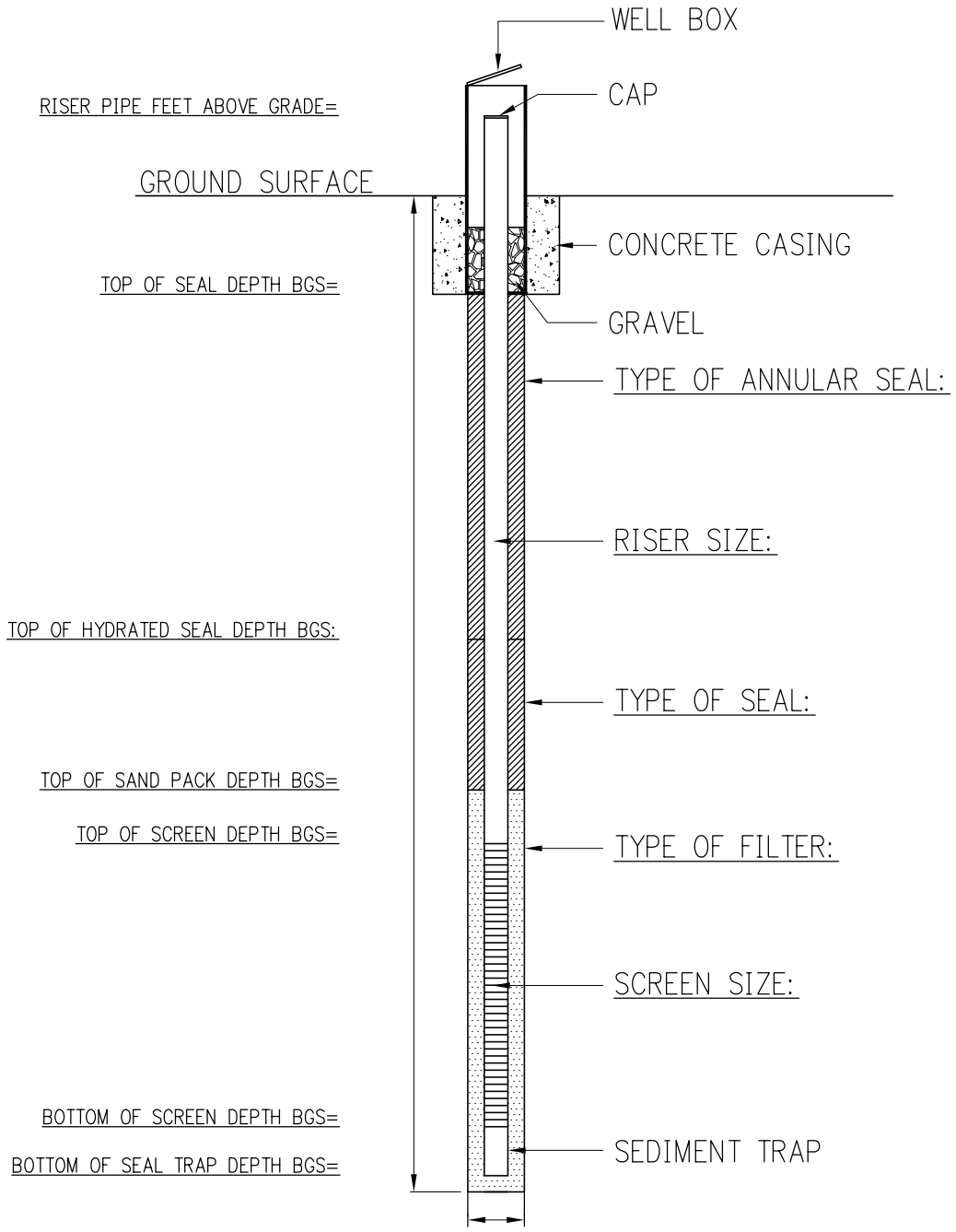
REMARKS:

I:\CAD\BMC\TEMPLATES\FLUSH MOUNT WELL LOG.NL

WELL INSTALLATION LOG

No. _____

CLIENT	COORDINATES N E	PROJECT	PROJECT NO.
PROJECT LOCATION		TOP OF RISER ELEVATION (DATUM)	DATE
STRATUM MONITORED		LOGGED BY	
DRILLING COMPANY		APPROVED BY	



NOT TO SCALE

METHOD OF INSTALLATION:

REMARKS:

I:\CAD\BMC\TEMPLATES\STICK UP WELL LOG NL

STANDARD OPERATING PROCEDURE NO. SAS-05-04

WELL DEVELOPMENT Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for developing wells. Well development is conducted to 1) remove drilling fluids or mudcake from the filter pack, borehole wall, and formation materials, 2) remove any loose, fine-grain, formation materials (e.g. fine sand, silt, and clay) from the filter pack and well screen to eliminate, to the extent possible, impact the integrity of groundwater and/or product samples and aquifer characterization test results, and 3) restore the natural permeability of the formation adjacent to the borehole.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials will vary by development method. Field personnel should use the equipment and materials required by the Work Plan or otherwise specified for the development method(s) selected for the project. All non-disposable equipment, including pumps, hoses, containers, and bailers, shall be decontaminated before and after introduction into wells. Equipment decontamination should be performed in accordance with SOP ENV-04-05 and/or requirements of the Site-Specific Work Plan.

3.0 HEALTH AND SAFETY WARNING

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 DEVELOPMENT METHODS

4.1 Air Lifting

The airlift method involves pumping compressed air down an eductor pipe placed inside the well casing. Due to its inert characteristic, nitrogen is the preferred gas for air lifting. Pressure is applied intermittently and for short periods causing the water to surge up and down inside the casing. Once the desired surging is accomplished, continuously applied air pressure should be used to blow water and suspended sediments upward and out of the well.

The use of standard air for well development may impact permeability of the formation surrounding the well screen and groundwater quality. Considerable care must be exercised to avoid injecting air directly through the well screen. Air can become trapped in the formation materials outside the well screen and affect subsequent chemical analyses of water samples and hydraulic conductivity measurements. The bottom of the air pipe should not be placed below the top of the screened section of casing.

Another restriction of the use of air is the submergence factor. The submergence factor is defined as the height of the water column above the bottom of the air pipe (in feet) divided by the total length of the air pipe. To result in efficient airlift operation, the submergence factor should be at least 20 percent. This may be difficult to achieve in shallow monitoring wells or wells that contain small volumes of water.

4.2 Surging or Plunging

A surge block is a round plunger with pliable edges (constructed of a material such as rubber belting) that will not catch on the well screen. Moving the surge block forcefully up and down inside the well screen causes the water to surge in and out through the screen accomplishing the desired cleaning action. The amount of pressure generated by the surging must be closely monitored to prevent cracking of the well casing or screen.

A well slug may also be used to create a surging effect through the filter pack and formation. A slug consists of a PVC rod or pipe (with capped ends) sufficiently weighted to rapidly sink in water. The slug is alternately lowered into and retrieved from the water in the casing to create a water level differential that induces flow

into or out of the well to accomplish the desired cleaning action. This method is less aggressive than using a surge block. For shallow wells or wells in which the water column in the casing is small, care must be exercised when lowering the slug so as not to drive the slug into the bottom of the casing or against the screens.

4.3 Bailing or Pumping

Bailers may be used for development of low-yielding wells or wells with a significant amount of sediment (approximately 10% in the well screen) to remove excess sediment. A bailer that is heavy enough to sink rapidly through the water can be raised and lowered through the water column to produce the surging action that is similar to that caused by a surge block or well slug. The bailer, however, has the added capability of removing turbid water and fines each time it is brought to the surface. Bailers are very useful for developing shallow and slow yielding wells. As with surge blocks, it is possible to produce pressure great enough to crack PVC casing. Bailers are the simplest and least costly method of developing a well, but are time-consuming.

Pumping can be used effectively in wells where recharge is rapid. The pump may be used to back flush and overpump (at rates that exceed purging and sampling rates) water in and out of the well screen. The type and size of the pump used is contingent upon the well design. Pumps also allow removal of turbid water and fines. However, pumps are more difficult to decontaminate than a bailer is.

5.0 EXECUTION

The following procedures shall be adhered to unless well development requirements are otherwise specified in the Site-Specific Work Plan:

1. Measure the depth to groundwater in accordance with the guidelines described in SOP ENV-08-02. The standing water volume (V) in the well to be developed shall be calculated using one of the following formula in accordance with the Site-Specific Work Plan:

   Borehole Volume Calculation

   $V = nA (B - C) + CD$

   Where, n = porosity of the filter pack;
   A = height (in feet) of the saturated filter pack;

B = volume (in gallons per foot) of water in the borehole (see Table below);
C = volume (in gallons per foot) of water in the well casing (see Table below); and
D = height of standing water column (in feet) in the well.

Well Volume Calculation

V = CD

Where, C = gallons per foot of water in the well casing (see Table below); and
D = height of standing water column (in feet) in the well.

Diameter-Specific Volume Per One Foot of Casing/Borehole

Diameter (Inches)	Volume Per Foot of Casing/Borehole (Gallons)		Diameter (Inches)	Volume Per Foot of Casing/Boring (Gallons)
0.25	0.0026		4.0	0.6528
0.50	0.0102		6.0	1.469
0.75	0.0230		8.0	2.611
1.0	0.0408		10.0	4.081
2.0	0.1632		12.0	5.876

2. Measure water quality parameters immediately prior to and during well development at a minimum frequency of once per well volume removed in accordance with SOP ENV-08-03. The water quality parameters should generally include pH, specific conductance and/or actual conductivity, temperature, dissolved oxygen, and turbidity, unless otherwise specified in the Work Plan. Record water quality parameters, as well as visual turbidity and evidence of impact (e.g. free phase product, sheen, odors, etc.) observations in the field logbook and/or on the appropriate field form.
3. Remove 10 standing water volumes or the volume required to achieve water quality parameter stabilize and visual clarity is achieved, whichever is less. A well that will not yield sufficient volume must be slowly bailed or pumped, allowed to recover to within 90% of the pre-development standing water volume, and then slowly bailed or pumped a second time, with a maximum of five purge periods. The criteria for parameter stability are summarized below.

4. Increase the minimum development water volume when drilling water and/or fluids are lost prior to well development. This additional purge volume shall be at least three times the volume of lost fluid.

Water Quality Parameter	Stability Criteria[1]
pH	+/- 0.1 Std. Units
Temperature	+/- 0.1°C
Specific Conductance or Actual Conductivity	+/- 3% microsiemens/cm
Dissolved Oxygen	+/- 0.3 milligrams/Liter
Turbidity	<10 NTUs or + 10% when turbidity is greater than 10 NTUs and/or visually clear water

5. Containerize development water in approved, labeled containers (e.g. 55-gallon drums, polyethylene storage tanks, baker tanks, etc.) as required by the Site-Specific Work Plan or otherwise specified.

6.0 DOCUMENTATION

Well development activities will be documented in the field logbook and/or appropriate field form included in Appendix B of the FSP, describing the procedures used and any significant occurrences that are observed during development such as apparent recharge rates in the well, condition of the groundwater, and organic vapor readings. Well development data including the depth to static water, standing water volume in the well, standing water volume calculations, total volume of water removed, number of well volumes removed, and water quality parameters will be recorded in the field logbook and/or on the field activity form (Appendix B of the FSP).

7.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 1992, Monitoring Well Development Guidelines for Superfund Project Managers, Office of Solid Waste and Emergency Response, http://www.epa.gov/tio/tsp/download/welldevelp.pdf.

USEPA, 2002, Ecological Assessment Standard Operating Procedures and Quality Assurance Manual, SESD, Region 4, Ecological Assessment Branch, Athens, Georgia.

[1] USEPA, May 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, Revision 2, EPA/542/S-02/001.

USEPA, May 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, Regions 5 and 10, EPA/542/S-02/001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-05-05

BOREHOLE AND WELL ABANDONMENT Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for borehole and well abandonment. When boreholes and wells are no longer needed to complete project goals and objectives, they must be properly abandoned to prevent them from acting as a conduit for migration of contaminants from the ground surface to the water table or between transmissive zones.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials may vary based on borehole and well accessibility and depth and well construction. Field personnel should use the equipment and materials required by the Site-Specific Work Plan or otherwise specified for the project. All non-disposable equipment shall be decontaminated before and after introduction into borehole or well. Equipment Decontamination should be performed in accordance with SOP SAS-04-05 and/or requirements of the Site-Specific Work Plan.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

Borehole and well abandonment procedures should meet applicable regulatory agency requirements. In addition, licensing and/or certification of the driller may be required. A trained supervising technician (e.g. geologist, hydrogeologist, engineer, or environmental scientist) should be present during well abandonment to document the activities. The supervising technician should complete and submit a well abandonment form, if required, to the appropriate regulatory agency. Attachment A contains the Illinois Department of Public Health Water Well Sealing Form as an example. If wells are abandoned in other states, the relevant forms and procedures shall be implemented.

5.0 EXECUTION

Unless otherwise specified in the Site-Specific Work Plan, the following guidelines shall be followed. The preferred well abandonment method is to completely remove the well casing and screen from the borehole. This may be accomplished by auguring with a hollow-stem auger over the well casing down to the bottom of the borehole, thereby removing the grout, bentonite seal, and filter pack from the hole. The well casing shall be then removed from the borehole with the drill rig. The remaining borehole and boreholes not utilized for the construction of a monitoring well, is subsequently backfilled with the appropriate backfill material. The backfill material (e.g. bentonite, Portland cement, etc) shall be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method) to within 30 inches of the ground surface. . The annular space shall be filled with bentonite chips, grout, or granules to at least 30 inches bgs unless land use requires a design modification to use native material (gravel, soil, etc.) or material in adjacent areas (asphalt, concrete, etc.) to bring the former well location to grade. If the area has heavy traffic and/or construction use, the location will be barricaded until the plug has cured or concrete plug recessed below ground surface will be used to maintain the surface seal. This abandonment method can typically be accomplished on small-diameter wells (4-inches or less in diameter) without much difficulty.

The use of hollow-stem augers for casing removal on large-diameter wells (diameter greater than 4-inches) typically ranges from very difficult to almost impossible. On large-diameter wells with little to no grout, a drill stem with a tapered wedge assembly or solid-stem auger should be used to ream out the borehole and extract the well materials. Wells that are badly corroded and/or have thickly grouted annular space have a tendency to twist and/or break off in the borehole. Should this occur, the well would be grouted with the

remaining casing left in the borehole. In this case, the well and borehole shall be pressure grouted by placing a tremie pipe in bottom of the well casing, which will be the well screen or bottom sump area below the well screen. The pressurized grout will be forced out through the well screen into the filter pack and up the inside of the well casing sealing holes and breaks that are present. The tremie pipe shall be retracted slowly as the grout fills the casing. The annular space shall be filled with bentonite chips, grout, or granules to at least 30 inches bgs. The well casing shall then be cut off at least 30 inches below. Native material (gravel, soil, etc.) or material in adjacent areas (asphalt, concrete, etc.) may be used to bring the former well location to grade. If the casing has been broken off below the surface, the grout shall be tremied to within 30 inches of the ground surface and then finished similar to the surrounding features.

Brittle polyvinyl chloride (PVC) well casings may be more difficult to remove from the borehole than stainless-steel casings. If the PVC well casing breaks during removal, the borehole shall be cleaned out by using a drag bit or roller cone bit with the wet rotary method to grind the casing into small cuttings that will be flushed out of the borehole by the drilling fluid. Another method is to use a solid-stem auger with a carbide auger head to grind the PVC casing into small cuttings that will be brought to the surface by the rotating flights. After the casing materials have been removed from the borehole, the borehole shall be cleaned out and pressure grouted with the approved grouting materials. As previously stated, the borehole shall be finished with a concrete surface plug or site-specific surface restoration material with adequate surface protection, unless otherwise directed or required by the Site-Specific Work Plan.

6.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2005, D5299-99 (2005) Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

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ATTACHMENT A
BOREHOLE / WELL ABANDONMENT FORM

BOREHOLE / WELL ABANDONMENT FIELD FORM

PROJECT INFORMATION

Site: _____ Client: _____

Project Number: _____ Task #: _____ Start Date: _____ Time: _____

Field Personnel: _____ Finish Date: _____ Time: _____

GENERAL INFORMATION

Ownership (Controlling Party): _____

Street Address: _____

City: _____

County: _____

State: _____ Zip: _____

Township: _____ Range: _____ Section: _____

_____ 1/4 of the _____ 1/4 of the _____ 1/4

If Known, Latitude: _____ Longitude: _____

If Known*, Northing: _____ Easting: _____

*Coordinate System: _____

Reason for Abandonment:

Permit Number (If applicable): _____

BOREHOLE / WELL INFORMATION

Borehole / Well ID: _____ Unique Well ID:

Installation Date: _____

☐ Borehole
☐ Monitoring Well
☐ Water Well
☐ Other (specify): _____

Attach Well Completion Report, if available

Construction Type:

☐ Drilled ☐ Driven (Sandpoint)
☐ Other (specify): _____

Formation Type:

☐ Unconsolidated Materials ☐ Bedrock

Borehole/Well Details:

Borehole Diameter: _____ Inches

Total Borehole Depth: _____ FT BGS

Casing Diameter: _____ Inches ☐ Not Applicable

Total Casing Depth: _____ FT BGS ☐ Not Applicable

Depth to Water: FT BGS ☐ Not Encountered

SEALING INFORMATION

Pump & Piping Removed? ☐ Yes ☐ No ☐ Not Applicable

Liner(s) Removed? ☐ Yes ☐ No ☐ Not Applicable

Screen Removed? ☐ Yes ☐ No ☐ Not Applicable

Entire Casing Removed? ☐ Yes ☐ No* ☐ Not Applicable

If No, Upper 2 feet Removed? ☐ Yes ☐ No

Method of Sealing Material Placement:

☐ Conductor Pipe - Gravity ☐ Tremie Pipe - Pumped

☐ Screened & Poured ☐ Other (specify): _____

Sealing Material Rose to Surface? ☐ Yes ☐ No

Material Settled After 24 Hours? ☐ Yes* ☐ No

*If Yes, Was Hole Re-Topped? ☐ Yes ☐ No

Sealing Material Used	From	To	Volume/Quantity
	Surface		

SEALING WORK PERFORMED BY

Individual's Name: _____ License Number:

Company Name: _____

Street Address: _____

City: _____ State: _____ Zip: _____

STANDARD OPERATING PROCEDURE NO. SAS-05-06

TEST PIT EXCAVATION, LOGGING AND SAMPLE COLLECTION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for conducting test pit excavation, logging and sample collection as described in the Site-Specific Work Plan, or as otherwise specified, for the purposes of characterizing subsurface conditions at the site.

2.0 EQUIPMENT AND MATERIALS

- General:
  - Excavator or backhoe;
  - Metal shovel;
  - Spray paint or survey lathe and tape;
  - Visquene sheeting;
  - Tape measure in 0.01-foot increments;
  - Field logbook and field boring log forms;
  - Pen(s) with waterproof, non-erasable ink;
  - 5-gallon bucket and wire or nylon brushes, decontamination water, laboratory grade detergent (Alconox or similar), and paper towels;
  - Aluminum foil or roll-plastic wrap;
  - Stakes and fluorescent flagging tape;
  - Camera; and
  - Personnel protective equipment, as appropriate.
- Soil Logging:
  - Knife, spatula, carpenter's 5-in-1 tool or similar cutting tool;
  - Soil color chart;
  - Comparative charts; and

- Pocket penetrometer.

- Soil Sampling:
  - Sample containers and labels;
  - Sample cutting/extracting equipment (scoops, trowels, shovels, hand augers);
  - Metal mixing bowls;
  - Coolers and ice;
  - Chain of custody forms;
  - Custody seals;
  - Gallon size sealable plastic bags; and
  - Clear plastic packaging tape.

3.0 HEALTH AND SAFETY WARNING

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 GENERAL PROCEDURES

Test pit procedures shall be conducted only by a trained logging technician. Subsurface utilities shall be cleared prior to mobilization to the site in accordance with SOP ENV-05-01. Field data and observations associated with test pit activities shall be documented in accordance with SOP ENV-01-01, if not otherwise specified in this SOP. All test pit excavation activities should be recorded in a field logbook and/or on a test pit excavation field form. In addition, equipment used while logging shall be decontaminated between test pit locations in accordance with the SOP ENV-04-05 or as otherwise specified in the Quality Assurance Project Plan (QAPP) and/or Site-Specific Work Plan.

5.0 DOCUMENTATION PROCEDURES

The field technician shall record all pertinent excavation information in the field logbook and/or on the appropriate field form. At a minimum, the following technical information with respect to excavation operations and observations shall be recorded, if applicable:

- Project name and number;
- Location (e.g. test pit number) or other sample station identification, including a rough sketch;
- Name of the logging technician overseeing the excavation operations;
- Excavating equipment manufacturer and model;
- Excavating company name and city and state of origin;
- Equipment operator and assistant(s) names;
- Excavation start time and date;
- Excavation completion time and date;
- Excavation dimensions (length and width, and depth)
- Description of soil and/or rock classification and lithology;
- Lithologic changes and boundaries;
- Depth to water first encountered during excavation
- Depth to stabilized water level following excavation
- Sample identifications; depths and time collected for chemical and geotechnical samples;
- Evidence of impact (e.g. staining, odors, free-phase product, etc.); and
- Problems with the excavating equipment or process.

6.0 TEST PIT EXCAVATION PROCEDURES

- Identify the test pit locations and mark limits of excavation using spray paint or survey lathe and tape.
- Confirm absence of subsurface utilities in the test pit excavation areas. If subsurface utilities are present in test pit location, contact the project manager to discuss alternative locations for test pit.

- Lay visquene sheeting to be used for soil stockpiling on ground next to test pit location and secure in place. If topsoil is present, it may be stockpiled separately for restoration of ground surface when test pit is completed.
- Begin excavation making shallow cuts of 6 inches to 1 foot to allow descriptive logging of soil and soil transitions. Stockpile soil on visquene sheeting.
- Sketch the development of the test pit in the field notebook. Complete vertical profiles at multiple locations along the length of the test pit if variation of subsurface materials occurs along the length. Sketch a cross section of the longitudinal length of the test pit.
- Record physical characteristics of the material excavated including Unified Soil Classification System (USCS) soil type, litho logy, color, odor, moisture, structures, foreign objects and observations of environmental impacts in the field logbook or field form. Follow soil description, classification, and visual observations of affected soil procedures provided in SOP ENV-05-02.
- Take photographs to document excavation and log photographs in the field logbook or on the field form.
- If soil samples are required for chemical or geotechnical analysis, collect samples from the base or side walls. If the test pit depth has unsafe conditions (deeper than can be safely accessed, unstable walls, or other safety concerns), collect samples directly from the excavation bucket or soil stockpile. Samples will be collected as soon as possible to minimize potential volatilization from soil in the bucket of the excavator or soil stockpile. Have communication signals set up with excavator operator and/or other subcontractor personnel to indicate that a soil sample will be taken so that the equipment can be stopped for safe sample retrieval. Do not at any time go into the test pit.
- Soil samples shall be collected in accordance with SOP ENV-06-01. Decontaminate sampling equipment between each sample collected in accordance with SOP ENV-04-04. Samples shall be prepared for analysis in accordance with SOP ENV-03-01.
- Once the excavation is complete, record the depth, length and width of the excavation in the field logbook or on the field form.
- Backfill the test pit with the material excavated from the test pit unless other backfilling instructions are specified in the Site-Specific Work Plan. If topsoil was set aside for ground surface restoration, place it on top of the excavation area.
- Decontaminate excavator or backhoe bucket between each test pit in accordance with SOP ENV-04-04.

- Test pits must be backfilled before the end of the work day; no test pits shall be left open overnight.
- Replace markings for limits of test pit excavations if they are to be located by survey at a later date.

7.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-05-07

TEST PIT BACKFILLING AND COMPACTION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for backfilling and compacting test pits. When test pits are no longer need to complete project goals and objectives, they must be properly backfilled and compacted to minimize health and safety liabilities, prevent them from acting as a conduit for migration of contaminants, and return the location to pre-excavation conditions.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials may vary based on test pit accessibility and depth. Field personnel should use the equipment and materials required by the Site-Specific Work Plan or otherwise specified for the project. All non-disposable equipment shall be decontaminated after introduction into the test pit. Equipment decontamination should be performed in accordance with SOP ENV-04-04 and/or requirements of the Site-Specific Work Plan.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

The preference for test pit backfilling is generally to return excavated materials to the test pit in the order in which they were excavated. However, the presence of suspected contaminants may require another source of backfill material. The selection of backfill material will be based on several factors, including but not limited to, concentrations of contaminants in excavated materials, test pit location (e.g. street, landscaped area, etc.), subsurface site features, ability to mechanically compact backfill materials, engineering evaluations, health and safety concerns, and access agreements. If the test pit extends below the water table, 3-inch stone shall be used to backfill the excavation to the top of the water table. Backfill material(s) will be specified in the Site-Specific Work Plan. The excavation area shall be returned to pre-excavation conditions or as otherwise specified in the Site-Specific Work Plan, applicable permit(s), and/or access agreement(s). As necessary, a qualified engineer will be consulted prior to selection of backfill and compaction material(s), equipment and method(s).

5.0 BACKFILLING AND COMPACTION

5.1 Trench Box Methods

The test pit excavated using a trench box will be backfilled, as the trench box is systematically raised, to ground surface. Care will be taken to minimize bridging as the backfill is placed. When test pit excavations exceed 4 feet in depth and self-compacting backfill material is not used, the backfill material will be placed in lifts and compacted using the excavator bucket, excavator track/wheel, or vibratory plate compactor or as specified in the Site-Specific Work Plan, applicable permit(s), and/or access agreement(s).

5.2 End Dump Methods

Test pits excavated without a trench box could be backfilled using end dump methods. When test pit excavations exceed 4 feet in depth and self-compacting backfill material is not used, the backfill material will be placed in lifts and compacted using the excavator bucket, excavator track/wheel, or vibratory plate compactor or as specified in the Site-Specific Work Plan, applicable permit(s) and/or access agreement(s).

6.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

SOP SERIES SAS-06

SOIL SAMPLING AND MEASUREMENT PROCEDURES

STANDARD OPERATING PROCEDURE NO. SAS-06-01

SOIL SAMPLING FOR CHEMICAL ANALYSES AND GEOTECHNICAL TESTING Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for obtaining surface and subsurface soil samples as stated in the Site-Specific Work Plan or as otherwise specified. Soil sampling is conducted for the purpose of chemical analyses and geotechnical testing to evaluate surface and subsurface conditions.

2.0 EQUIPMENT AND MATERIALS

In addition to materials provided by a subcontractor, the field personnel should have the following:

- Sample bottles/containers and labels;
- Sample cutting/extracting equipment (scoops, trowels, shovels, hand augers);
- Field logbook and/or the appropriate field form(s);
- Depth and length measurement devices with 0.01-foot measurement units;
- Camera;
- Stakes and fluorescent flagging tape;
- Decontamination materials;
- Coolers and ice;
- Chain of custody forms;
- Custody seals;
- Gallon size sealable plastic bags;
- Clear plastic packaging tape; and
- Personal protective equipment.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 SAMPLE TYPE, METHOD, AND EQUIPMENT SELECTION

4.1 Preparation

Site-Specific Work and/or Field Sampling Plans (FSP) which involve soil sampling shall be carefully conceived with respect to data quality objectives (DQOs) and cost effectiveness. Soil samples shall be strategically located to collect a representative fraction of soils with the minimum number of samples. To facilitate complete and successful sampling efforts by minimizing uncertainties with respect to site characterization the following factors shall, at a minimum, by considered during preparation activities:

- Project goals and DQOs;
- Location and duration of historical property uses (if available);
- Location and duration of current property uses;
- Chemical properties of contaminants of potential concern (COPCs);
- Anticipated location(s) of COPCs (e.g. surface, subsurface, etc.);
- Anticipated geologic conditions including presence and elevation of groundwater;
- Site accessibility; and
- Results of previous site reconnaissance and investigations (if available).

4.2 Field Considerations

Field personnel shall review and be familiar with Site-Specific Work and/or FSPs prior to commencement of sampling activities. Field personnel will also facilitate complete and successful sampling efforts by calibrating and operating field instruments/meters used for sample media screening in accordance with SOP ENV-02-01. In addition, field personnel shall be cognizant of the following during investigative activities:

- Indications of COPCs not previously anticipated;
- Evidence (e.g. visual, olfactory, etc.) of COPCs in locations not previously anticipated;
- Geologic conditions not anticipated;
- Changes in site accessibility; and
- Meteorological conditions (e.g. high humidity, rain, etc.) that have the potential to negatively impact operation and performance of field screening instruments, and sample quality.

Field personnel shall notify the Project Manager when field conditions and observations deviate from those anticipated during sampling event preparations. The Project Manager shall approve any deviation from the Work and/or Sampling Plans prior its occurrence. Deviations and approval to deviate from Site-Specific Work and/or FSPs shall be documented in the field logbook and/or on the appropriate field form by the field personnel.

5.0 SAMPLE TYPES

5.1 Grab Samples

Grab samples are collected to identify and quantify compounds at a specific location or interval. Grab samples are limited in areal and vertical extent. A grab sample shall be comprised of no more than the minimum amount of soil necessary to obtain the volume of sample dictated by the required sample container.

5.2 Composite Samples

Composite samples are a mixture of a given number of sub-samples/aliquots and are collected to characterize the average composition of a given surface area, vertical interval, etc. The number of sub-samples/aliquots forming a composite sample shall remain consistent with the context of the investigation. The number and pattern for collection of sub-samples/aliquots within a grid, interval, etc. shall be selected based on project goals and DQOs and shall not change. Composite sampling is associated with two potential interferences:

1. Low concentrations, if present in individual sub-samples/aliquots, may be diluted to the extent that the total composite concentration is below the analytical reporting limits.
2. Sub-samples/aliquots that are predominantly moist clay can be difficult to composite to produce a homogenous mixture. The resulting sample, as represented by the portion selected by the analytical chemist, may not be representative of an average of all the sub-samples/aliquots.

6.0 SAMPLING METHOD

6.1 Random

Random sampling removes the subjective collection of samples based on personal judgment. Soil samples are typically selected from all investigation area(s) when a suspected area of contamination is unknown. Generally, this method is utilized with site screening investigations when there is no strong indication of contamination or distinct depositional areas are present that provide excellent screening samples.

6.2 Biased

Biased sampling involves the collection of samples based on evidence of contamination (e.g. staining, stressed vegetation, elevated field screening results, etc.). Background and control samples are also considered biased, since they are collected from locations anticipated to be impacted or expected to be clean.

6.3 Grid-Based

Grid-based sampling involves the systematic collection of samples based on the size and configuration of an area. This approach is used to characterize the presence and distribution of contaminants and is commonly utilized for large areas. Grid size will be selected during the preparation phase and shall be specified in the Work or Sampling Plan. Common grid sizes shall be developed based on the size and configuration of the area, project goals, and DQOs. It may be appropriate and acceptable to integrate several different grid sizes in a single investigation.

When a Site is extremely large (typically over several acres), it may not be practical and cost-effective to consider sampling every grid. In this case, it will be necessary to statistically select a sub-set of the total number of grids in order to reduce the number of samples collected. On the other hand, it may be more appropriate to use relatively inexpensive screening level analytical techniques to define the areas that will

need to be sampled and analyzed for a higher level of data quality. In all cases, grid points shall be located using a site survey and shall be semi-permanently marked to facilitate relocating the sample locations for subsequent sampling.

7.0 SAMPLING EQUIPMENT AND PROCEDURES

7.1 Manual Sampling

In general, hand sampling using manually operated equipment is a quick and inexpensive sampling technique for shallow depths when precise data or high quality control is generally not required. The most common hand-operated samplers are hand augers, plugs, tubes, split-barrel or fixed piston samplers that are pushed or driven by hand.

Hand augers are easily used at depths less than 10 feet. The most commonly used, manually-operated hand augers include the ship, closed-spiral, and open-spiral augers. In operation, a hand auger shall be attached to the bottom of a length of pipe that has a cross-arm at the top. The hole shall be drilled by turning this cross-arm at the same time the operator presses the auger into the ground. As the auger is advanced and becomes filled with soil, it shall be taken from the hole, and the soil shall be removed. Additional lengths of pipe will be added as required to reach the sampling depth as required by the Site-Specific Work Plan or otherwise specified. Care shall be taken to prevent (to the extent possible) mixing of the soil from upper portions of the hole with lower samples. This is most likely to be a problem when augers are used to advance a hole and obtain samples from soil cuttings.

Pushed samplers can be used to obtain samples within about 3 feet of the surface or, with appropriate extensions, ahead of an augured hole. The sampler will be pushed to the desire depth by the operator. The pusher sampler shall be used with extension(s) and/or in combination with a hand auger to reach sample depths greater than 3 feet below ground surface. When the sampler becomes filled with soil, it shall be taken from the hole and the soil removed. Care shall be taken to prevent mixing of soil from upper portions of the hole with lower samples.

Because of the unpredictable operations that may have been used at many uncontrolled waste sites, sampling devices will never be forced into an abruptly hard material. The stiffness may be a natural lithology change, a rock ledge or cobble, or a buried drum. If resistance is encountered while auguring or pushing a sampler, the procedure will be stopped. The depth at which resistance was met should be recorded into the field logbook and/or on the appropriate field form.

7.2 Split-Spoon Sampler

The split-spoon sampler is a thick-walled steel tube that is split lengthwise. A cutting shoe is attached to the lower end of the barrel; the upper end contains a check valve and is connected to the drilling rods. When a boring is advanced to the point that a sample is to be taken, drill tools are removed, and the sampler is lowered into the hole attached to the bottom of the drill rods.

The split-spoon sampler is driven by a 140-lb hammer falling 30 inches. The split-spoon sampler shall be driven 18 inches into the ground or until 50 blows have been applied in a 6-inch increment, a total of 100 blows have been applied, or there is no observable advance of the sampler after 10 successive blows. The effort taken to drive the sampler shall be recorded at 6-inch intervals and the sampler shall be removed from the boring. The density of the sampled material shall be determined by summing the blow counts for the second and third 6 inches of penetration ("standard penetration resistance" or "N-value") per ASTM D 1586-99. Only disturbed samples are obtained using this procedure.

The standard size split-spoon sampler is 2-inch outside diameter (OD), $1^3/8$-inch inside diameter (ID), and 24 inches long. When soil samples are taken for chemical analysis, a 2- or 2½-inch ID sampler shall be used to provide a larger volume of material, but cannot be used to calculate strength or density properties as stated in the ASTM D 1586-99 test method.

Upon retrieval, excess soil or drilling fluid shall be rinsed or wiped from the sampler's exterior, the cutting shoe removed, and sampler broke open into the two halves. The sample shall be logged and classified in accordance with SOP ENV-05-03. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-approved and analytical-method required sample containers. The sampler tube

shall then be decontaminated. The split-spoon sampler shall be decontaminated between sample intervals in accordance with SOP ENV-04-05.

Liner tubes or sleeves may be incorporated in certain samplers to contain samples temporarily. The liner tubes may be constructed from brass, plastic, or other inert materials used to store and transport the samples. If a sample is to be stored in the liner tube, the tube ends shall first be covered with Teflon film, followed by a plastic slip cap. On each sample end, the Teflon film shall be trimmed, and the cap sealed with vinyl tape to the liner tube. If the sampler is not to be stored in the liner, it will be transferred from the sampler to the appropriate sample container using either the liner tube or a stainless steel or plastic spoon or spatula.

When taking samples for geotechnical testing, the disturbed soil samples shall be removed from the sampler are placed in a sealable glass jar or other containers approved by the geotechnical laboratory and labeled to indicate the project name and number, boring number, sample number, and depths at top and bottom of the sample interval. This information shall be marked on the jar lid using a permanent marker. Other information required by the Site-Specific Work and/or FSP shall be recorded in the field logbook and/or on the appropriate field form.

7.3 Continuous Core Barrel Sampler (CME-Type)

A continuous core barrel sampler (CME-Type) is 5 feet long and fits inside the lead auger of the hollow-stem auger column. The sampler retrieves a 5-foot section of partially disturbed soil samples. The sampler assembly consists of either a split barrel or solid barrel that can be used with or without liners. The split-barrel sampler is most commonly used because it is easier to access and remove the core samples. The core barrel sampler takes the place of the pilot bit, thereby reducing sampling time. The sampler is most efficient in clays, silts, and fine sand.

The sampler shall be attached to the drill rod and locked in-place inside the auger column. The open end of the sampler shall extend a short distance ahead of the cutting head of the lead auger. The hollow-stem auger column shall be advanced 5 feet while the soil enters the non-rotating core sampling barrel. The barrel shall then be retrieved with the drill rod, and the core extruded from the sampler. The sample shall be logged and

classified in accordance with SOP ENV-05-03. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-approved and analytical-method required sample containers. The sampler tube shall then be decontaminated in accordance with SOP ENV-04-05.

7.4 Thin-Walled (Shelby) Tube Samplers

Thin-walled samplers, such as a Shelby tube, should be used to collect relatively undisturbed samples of soil from borings. The samplers are constructed of steel tubing about 1 to 3 mm thick, depending upon its diameter. The lower end has a tapered cutting edge. The upper end is fastened to a sample head adapter with a check valve to help hold the sample in the tube when the tube is being withdrawn from the ground. Thin-walled tube samples are obtained by any one of several methods including pushed-tube, Pitcher sampler, Denison sampler, and piston sampler methods.

In obtaining pushed-tube samples, the tube shall be advanced by hydraulically pushing it in one continuous movement with the drill rig. At the end of the designated push interval and before lifting the sample, the tube shall be twisted to break the bottom of the sample. The tube shall be retrieved from the boring using the drill rig. One of two methods shall be employed for handling the sample once it is retrieved from the boring:

1. Extruding the sample from the sample tube in the field using an extruding device on the drilling rig, and subsequently handling and containerizing the specimen at the drilling site.
2. Leaving the sample in the sampling tube, preparing it for transportation, with subsequent extrusion and handling elsewhere.

A hydraulic extruder shall be used in all cases to minimize disturbance. To extrude the sample from the tube, the tube shall be connected to the extruding device in the appropriate fashion for that type extruder. Some extruding devices push the sample in the same direction that the sample entered the tube, pushing out the top, while others push it out the bottom. It does not matter for environmental sampling, but the orientation of the sample shall be known and kept clear by the sampling personnel. The sample shall be caught on a split section of PVC pipe lined with polyethylene sheeting or aluminum foil. Waxed paper will not be used. Drilling fluids shall be carefully poured off and cuttings or slough material at the top end of the sample raked away, leaving only the true sample interval. The sample shall be transferred to a cutting board by lifting with

the poly/sheeting or aluminum foil and length of the sample shall be measured. The sample shall be logged and classified in accordance with SOP ENV-05-02. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-approved and analytical-method required sample containers. The sampler tube shall then be decontaminated in accordance with SOP ENV-04-04.

Shelby tubes will not be reused for subsequent sampling intervals. A sufficient number of decontaminated sampling tubes shall be brought to the sampling location to complete the required scope of work and protected from being contaminated before use.

7.5 Cuttings or Wash Samples

Drill cuttings or wash samples may be taken as the boring is advanced. A stainless steel or plastic scoop shall be used to obtain a sample from the cuttings pile. The shovel used by drilling personnel to move cuttings shall be stainless steel. The sample shall be logged and classified in accordance with SOP ENV-05-02. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-approved and analytical-method required sample containers. The sampling equipment shall then be decontaminated in accordance with SOP ENV-04-04.

7.6 Test Pit Excavation and Sampling

Test pits, including trenches, consist of open shallow excavations used to determine the subsurface conditions for engineering and geological purposes. Test pits are typically conducted for subsurface characterization and to investigate underground structures that may contain impacts. Test pits shall be excavated manually or by machine (e.g. backhoe, bulldozer, or trackhoe), as required by the Site-Specific Work Plan or otherwise specified, and will be in accordance with OSHA regulations, 29 CFR 1926, 29 CFR 1910.120, and 29 CFR 1910.134. Test pit shall be logged and classified in accordance with SOP ENV-05-06.

Soil samples shall be collected from the backhoe/trackhoe bucket or directly from the wall or base of the test pit, depending on the depth of the pit. Disturbed samples shall be collected using a stainless steel scoop, shovel, or trowel. Undisturbed samples shall typically be collected using a hand auger and/or other coring tool. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-

approved and analytical-method required sample containers. The sampling equipment shall then be decontaminated in accordance with SOP ENV-04-04.

7.7 Surface Soil Sampling

Surface soil samples are collected to determine the surface soil conditions. Surface soil samples are generally collected at depths of less than 1 to 3 feet below the ground surface or as defined in SSWPs, considering DQOs. The use of discrete or composite samples will be determined in the SSWPs.

Before sample collection, all surface materials (i.e., excess gravel, vegetation, etc.) shall be removed from the sample location. Soil samples shall be collected using a stainless steel scoop, trowel, hand auger, or other equipment as required by the Site-Specific Work Plan or otherwise specified. Samples for chemical analyses and/or geotechnical testing shall be collected using the laboratory-approved and analytical-method required sample containers. The sampling equipment shall then be decontaminated in accordance with SOP ENV-04-04. The sample appearance, depth, and location should be recorded in the field logbook and/or on appropriate field form using the standardized descriptions in SOP ENV-05-03, Attachment E.

8.0 ANALYTICAL SAMPLE PREPARATION

Sections of the sample representative of the entire sampling interval shall be selected for chemical analyses and/or geotechnical testing. Based on analytical requirement and contracted laboratory specifications, chemical analysis samples shall be placed in appropriate sample containers. Specific analytical sample preparation procedures are as follows.

- Using a decontaminated sampling instrument, remove the desired thickness and volume of from the sample retrieval device.
- Conduct a direct screening of the sample with a photoionization detector (PID).
- Visual observations of affected soil will use the descriptors from SOP ENV-05-02 Attachment E.
- Describe and classify the sample in accordance with SOP ENV-05-02, Field Logging of Soil and Rocks.
- **Volatile Organic Compounds (VOCs) –** Discrete soil samples for VOC analyses will be collected as soon after sample retrieval as possible. Unless otherwise specified, soil samples for VOC analyses shall be collected by either Powerstop Handle™ or EnCore™ sampler methods in conformance to USEPA

Method 5035 requirements. Attachment A presents procedures for Powerstop Handle™ and EnCore™ sample collection. Secure container lid, apply label containing sample identification information and place in cooler with ice.

- **Semivolatile Organic Compounds (SVOCs), Metals, Cyanide, PCBs, Pesticides, Herbicides, and Organic Carbon –** Soil samples for these analytes will be collected after collecting VOCs. Place soil in a container for homogenization. Samples will be homogenized using clean stainless steel mixing bowls, spoons, knifes, etc. Sample aliquots will be placed directly from the sample retrieval device into the stainless steel bowl. The soil will be thoroughly mixed in the bowl to homogenize the sample and then placed directly into appropriate sample containers. Secure container lid, apply label containing sample identification information and place in cooler with ice.
- **Physical Characteristics –** For geotechnical testing of cohesive samples, cut minimally disturbed sections of the specimen and place it in the appropriate sample container. Samples for geotechnical testing, including Shelby tubes shall be handled and packaged in accordance with standard practices for geotechnical investigations or as required by the Site-Specific Work Plan or otherwise specified. If contamination potentially exists, samples shall be identified as potentially containing hazardous or toxic chemicals.
- Samples shall be identified, labeled, documented and prepared for transport in accordance with SOP ENV-03-01, Sample Identification, Labeling, Documentation and Packaging for Transport.
- SOP ENV-03-2 Chain-of-Custody procedures shall be followed in preparing the samples for transport to the analytical laboratory.
- Sampling equipment and tools shall be decontaminated between each sample in accordance with SOP ENV-04-05.

Containerize any investigation-derived solid and liquid waste, including decontamination water, label and store for disposal at an appropriate disposal facility. Consult with Project Manager regarding disposal of waste.

Samples should be preserved and holding times should be observed according to analytical requirements and laboratory specifications, as required by the Site-Specific Work and/or FSPs, or as otherwise specified. If

replicate or split samples are required, adjust the sections so that the additional samples are essentially identical.

9.0 DOCUMENTATION

Sample identification, labeling, and custody control shall be performed in accordance with requirements specified in SOP ENV-03-01 and ENV-03-02. Specific procedures for describing the samples and logging subsurface soil samples are presented in SOP ENV-05-03. Soil sampling activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP ENV-01-01 or as required by the Site-Specific Work Plan.

10.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 1999, D1586-99 Standard Method for Penetration Test and Split-Barrel Sampling of Soils.

ASTM International, 2000, D4220-95 (2000) Practices for Preserving and Transporting Soil Samples.

ASTM International, 2004, D5730-04 Guide for Site Characterization for Environmental Purposes with Emphasis on Soil, Rock, the Vadose Zone, and Ground Water.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

ATTACHMENT A
ENCORE™ AND POWERSTOP HANDLE™ SAMPLING PROCEDURES

ENCORE™ SOIL SAMPLING PROCEDURE

- Remove EnCore™ sampler and cap from its re-sealable pouch and attach T-handle to sampler body. (**Note**: when dealing with soft or sandy solid, it may be necessary to retract the plunger in the sampler before sample collection.)
- Using the T-handle for leverage, push the sampler into a freshly exposed surface of soil until the sampler is full.
- Brush any soil off the sampler head and securely attach the sampler cap by pushing with a twisting motion.
- Complete the sample label and attach to the sampler body; place labeled sampler in its re-sealable pouch and seal the pouch.
- Repeat the procedure for two additional samples collected from the same soil stratum or the same area. (**Note:** this step may be eliminated or the number of samples reduced if the suspected level of VOCs is known [i.e., low or high concentration sample]. Consult method 5035 or discuss procedure with an analytical laboratory for further details.)
- Use a stainless steel spoon or similar tool to collect an additional sample from the same soil stratum or the same area. Place collected material in a 2-ounce, wide-mouth jar with no preservatives. (**Note:** this additional soil volume is for dry weight and percent moisture determination. This step is not necessary if additional soil from the sample location is collected for other parameter analyses upon which dry weight and percent moisture will be determined.)
- Immediately place samples in a cooler with ice.

Ship EnCore™ samples (next day priority delivery) to the contract laboratory the day they are collected. Alternatively, arrange to have samples picked-up by the laboratory or delivered to the laboratory by field personnel within 24 hours of collection. These sample shipment or pickup timelines must be achieved to ensure the laboratory performs sample preservation or analysis within 48 hours of sample collection.

POWERSTOP HANDLE™ SAMPLING PROCEDURES

1. Load Sampling Device

Insert EasyDraw Syringe™ into the appropriate slot (5 or 10-gram heavy, 5 or 10-gram medium, 5 or 10-gram light or 13 gram position) on the Powerstop Handle™ device and remove end cap from syringe.

EPA Method 5035 Recommended 5-gram slot positions:

- Use the heavy position for dense clay;
- Use the light position for dry sandy soil; and
- Use the medium position for all others.

2. Collect Sample

Push EasyDraw Syringe™ into a freshly exposed surface of soil until the syringe is full. Continue pushing until the soil column inside the syringe has forced the plunger to the stopping pint. (**Note**: unlike other sample collection devices, there is no headspace air in the syringe to displace.) EasyDraw Syringe™ delivers approximately 5, 10, or 13 grams. Actual weight will be determined at the laboratory. No scale or balance required in the field.

3. Eject Sample Into Vial

Remove the syringe from the Powerstop Handle™ device and insert the syringe into the open end of 40-ml vial, and eject sample into pre-tared vial by pushing on the syringe plunger. Avoid getting dirt on the threads of the 40-ml vial. Cap vial immediately and put on ice. Sample must be received by within 48 hours of sampling if samples are not chemically preserved in the field.

STANDARD OPERATING PROCEDURE NO. SAS-06-02

SOIL SAMPLING FOR MICROORGANISMS Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the collection of soil samples for analysis of their microbial constituents. While samples are generally collected from uncontaminated soils, samples collected from contaminated soils may be used to evaluate the feasibility and/or progress of natural or enhanced biotreatment activities. This SOP shall be used in conjunction with SOP ENV-06-01 (Soil Sampling for Chemical Analyses and Geotechnical Testing), which describe general soil sample collection techniques.

2.0 EQUIPMENT AND MATERIALS

Any of the equipment used to collect surface or subsurface soil samples may be used to obtain a volume of soil from which a sub-sample can be extracted using sterile techniques for microbial analysis. A stainless steel spoon or trowel, as described in the following sections, shall be used to collect the sub-sample. Sample containers must be sterile. Wide-mouthed 500-mL Pyrex or polypropylene bottles with autoclavable screw caps, which have been autoclaved for 15 minutes at 250°F and 15 psi or 530-mL sterile Whirl-pak® bags (Fisher Scientific Company) shall be used unless otherwise specified by the Work and/or Sampling Plan(s).

3.0 SPECIAL CONSIDERATIONS

The stainless steel spoon or towel used to collect the sample or sub-sample shall be decontaminated prior to sampling and following the collection of each sample or sub-sample in accordance with SOP ENV-04-05. Following the decontamination, either of the two sterilization procedures may be followed.

- Sterilization Procedure 1 - Spoons or trowels shall be individually packaged in aluminum foil and autoclaved for 30 minutes and 250°F at 15 psi. Each sterile sampler shall be used only once, decontaminated, and then re-sterilized.

- Sterilization Procedure 2 – The spoon or scoop portion of the trowel shall be dipped in denatured alcohol, shaken gently, and then ignited. Please note that this procedure may only be used if no flammable, ignitable, or explosives are present on Site.

4.0 EXECUTION

4.1 Surface Sample Collection

If samples are desired directly at the surface, sterile spoons or trowels shall be used to collect the samples. Samples shall be collected in accordance with the procedures outlined in SOP ENV-06-01 with the following exceptions:

1. In order to facilitate the collection of a representative sample, the top one-inch of soil shall be scraped from approximately one-square foot and the sample collected from the underlying material.
2. Samples will be placed into sterile containers, which shall be closed immediately and placed on ice. Please note that microbial samples are not to be frozen.

4.2 Subsurface Sample Collection

Shovels, core samplers, backhoes, split-spoon samplers, and thin wall tube samplers may be used to collect subsurface samples for microbial analysis. Augers or any method that disturbs the soil column shall not be used. Sample shall be collected in accordance with the procedures outlined in SOP ENV-06-01 with the following exceptions:

1. Once the volume of soil is collected by one of the above procedures, a sub-sample shall be collected from the center of the soil sample, avoiding all surfaces which have been in contact with the non-sterile sampling device.
2. Samples will be placed into sterile containers, which shall be closed immediately and placed on ice. Please note that microbial samples are not to be frozen.

5.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2004, D3694-94(2004) Standard Practices for Preparation of Sample Containers and for Preservation of Organic Constituents.

USEPA, 1978, Microbiological Methods for Monitoring the Environment, EPA-600/8-78-017.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

SOP SERIES SAS-07

SEDIMENT SAMPLING AND MEASUREMENT PROCEDURES

STANDARD OPERATING PROCEDURE NO. SAS-07-01

SEDIMENT THICKNESS DETERMINATION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the poling method of determining the thickness of soft sediments. Measurements shall be determined to assist in determining suitability of soft sediment for sample collection and information on the depositional environment in the sample collection location.

2.0 EQUIPMENT AND MATERIALS

- 2-inch diameter graduated aluminum pole or pole sections that can be placed together marked in one-foot increments that are subdivided into one-inch increments;
- Field logbook and/or the appropriate field form(s);
- Decontamination materials;
- Personal protective equipment; and
- Camera.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

The following procedure shall be followed unless otherwise specified by the Site-Specific Work Plan:

1. Maneuver the boat or wade to the sampling location. When wading, take care to minimize disturbance of soft sediment as much as possible by moving slowly.
2. Slowly lower the pole to the sediment surface to avoid disturbance of any flocculent sediment.
3. Stop when slight resistance is encountered, read the pole at the water surface to the nearest inch and record the measurement as the depth to top of sediment from water surface.
4. Push the pole into the sediment until refusal occurs.
5. Read pole at the water surface to the nearest inch and record the measurement as the depth to refusal measurement.
6. Slowly withdraw the pole from the sediment and water to keep sediment disturbance to a minimum.
7. Record any observations, such as type of sediment adhering to the pole and visible signs of contamination.
8. Decontaminate the pole or pole sections in accordance with SOP ENV-04-04.
9. Calculate the soft sediment thickness by subtracting the depth of top of sediment measurement from the depth of refusal measurement and record the calculation and result.

5.0 DOCUMENTATION

Sampling activities shall be documented in the field logbook or on an appropriate field form as outline in SOP ENV-01-01 and/or specified the Site-Specific Work Plan. Visual observations, as discussed above, shall also be recorded in the field logbook or on the field form.

6.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-07-02

DESCRIPTION AND CLASSIFICATION OF SEDIMENTS Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedure for field description and classification of sediments by means of visual inspection and manual testing.

2.0 EQUIPMENT AND MATERIALS

- Field logbook and/or appropriate field forms;
- Pens with waterproof, non-erasable ink;
- Munsell Soil Color Chart, GSA Rock Color Chart, or equivalent;
- Slim stainless-steel spatula or carpenter's 5-in-1 tool;
- Hand lens (optional);
- Camera;
- Decontamination supplies and equipment; and
- Personal protective equipment.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Work on water requires that marine health and safety procedures are used in addition to standard health and safety procedures. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully

understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 SEDIMENT DEFINITIONS

Sediments can be granular or chemical in composition. NOAA (1998) defines granular sediment as material for which percentages of individual components that make up the sediment can be determined by gross or microscopic inspection. Granular sediment can be composed of particulates from three classes of material: biogenic, mineral/lithic, and glass. The glass referred to is volcanic glass and is likely to be present in significant quantities only in areas of active or recent volcanic activity. Since areas with volcanic activity are rare on the North American continent, methods for describing volcanic glass sediments will be determined on a site-specific basis and will not be further discussed in this SOP. Biogenic material is the remains or traces of once-living organisms. Mineral/lithic material is all mineral grains not included in other granular sediment classes. Precipitates and carbonaceous materials occurring in quantities greater than 50 % are classified as chemical sediments and will not be discussed in this SOP.

5.0 GENERAL PROCEDURES

Sediment logging and material classification shall be conducted only by a trained logging technician (e.g. geologist, hydrogeologist, engineer, or environmental scientist). Field data and observations associated with field logging and material classification shall be documented during logging and for all investigation and sampling activities in accordance with SOP ENV-01-01, if not otherwise specified in this SOP. All field drilling activities shall be recorded in a field logbook or on the appropriate field form. In addition, tools and equipment used while logging sediment shall be decontaminated between sampling locations/stations and prior to each sampling event in accordance with the Quality Assurance Project Plan (QAPP).

6.0 SEDIMENT CLASSIFICATION PROCEDURES

6.1 General Classification

Determine if the sediment is primarily biogenic or mineral/lithic. If the sediment contains 30% or more of a single fossil group or 50% or more total biogenic content, classify the sediment as biogenic. This classification cannot always be determined in the field and may require additional microscopic inspection of

the sediment by a paleontologist or biologist. (Note: Classification of types of biogenic sediment beyond general terms of percentage composition and general physical characteristics by visual inspection is outside the scope of this SOP and will not be discussed further.) If the sediment contains mineral/lithic particles in excess of 50% by visual inspection, use a field classification of mineral/lithic.

6.2 Sediment Physical Classification

Classify the sediment sample similarly to soil using the ASTM visual-manual procedure (ASTM D2488-06). (See SOP ENV-05-02, Field Logging and Classification of Soil and Rocks for additional guidance.) If sample is biogenic, some of the following parameters may not apply. Record the following physical parameters, if applicable, in the field logbook or field form:

- Sample color, using Munsell color descriptors and identification numbers, immediately after sample collection;
- Sample color, using Munsell descriptors and numbers, after exposure to the air, if a color change occurs;
- Odor (identify organic odors by particular type if possible [e.g. petroleum-based]);
- Major sediment class (biogenic or mineral/lithic);
- Major mineral/lithic type (e.g. SAND, silty CLAY) or biogenic type (if possible);
- Other granular components and qualitative description of percentage using “with”, “some” or “trace”;
- Particle shape and angularity;
- Any depositional structures (stratification, lamination, etc.)
- Sample consistency;
- Sample grading (sorting) for coarse-grained samples;
- Dry strength, dilatancy, toughness and plasticity for fine-grained samples;
- Evidence of environmental impacts, if encountered (e.g. staining, sheen, or free-phase product) or any foreign materials (brick fragments, manufactured glass, coal fragments, etc.).

7.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2006, D2488-06 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

U.S. Department of Commerce, National Oceanographic and Atmospheric Agency (NOAA) 1998, Proposed NGDC/Curators' Classification for Granular Sediments (Modified from the ODP Sediment Classification Scheme), web address: http://www.ngdc.noaa.gov/mgg/curator/paula1.htm.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-07-03

SEDIMENT SAMPLING Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) presents guidelines for selecting sediment sampling locations and general procedures for the collection of sediment samples. This SOP addresses continental sediments only. Estuarine and oceanic sediment sampling is beyond the scope of this document and will not be discussed. This SOP addresses sample collection for characterization of chemical or physical parameters. Requirements for collection of samples for biological characterization are addressed in a separate SOP.

2.0 EQUIPMENT AND MATERIALS

Sampling equipment and materials vary be collection method. However, some standard equipment and materials are required regardless of collection method:

- Ruler or tape measure in 0.01 –foot increments;
- Sample containers and labels;
- Sample cutting/extracting equipment (scoops, spatulas, trowels, shovels, etc.);
- Field logbook and/or the appropriate field form(s);
- Depth measurement devices;
- Decontamination materials;
- Chain of custody forms;
- Custody seals;
- Coolers and ice packs;
- Personal protective equipment;
- Camera; and
- Global positioning system (GPS) (optional).

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Work on water requires that marine health and safety procedures are used in addition to standard health and safety procedures. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 PERMITTING

Sampling performed within navigable waters and critical habitats may fall under the jurisdiction of one or more federal, state, or local agencies, including by not limited to the United States Army Corp of Engineers (USACOE), US Department of Fish and Wildlife, and state Department of Natural Resources. Prior to the commencement of sampling activities, appropriate permit(s), if applicable, shall be obtained.

5.0 SAMPLE SITE SELECTION

The sediment sampling site will be selected based on a number of factors including among others the presence of environmental impacts on adjacent land, presence of water discharge or outfall area, type of water body (e.g. lake, river, pond, etc.), sediment type, and depth to sediment. In water that is generally navigable, the only requirement for site selection may be ability to access the investigational site by boat. Sediment investigations in rivers, creeks or canals, will usually require additional information for sample site selection including such factors as stream flow velocity; depth, cross section and plan view of stream, and man-made and natural structures that affect stream flow, among others. In many cases, the USACOE and state geological surveys have extensive records for US waters and should be consulted prior to sediment sampling site selection. An experienced geologist or hydrologist should also be consulted prior to site selection.

A pre-sampling site visit is necessary to determine access points and best locations for sampling. Current aerial or satellite photographs of the site may be viewed prior to the initial site visit to obtain a general overview of possible access and sampling locations. Sampling sites may be selected during the site reconnaissance. Sampling locations can be indicated by reference to onshore features, such as buildings, fence lines, trees, etc. If natural features, such as trees are used, they will be marked by paint or colored flags for easy identification. A sketch map will be drawn in the field logbook or on a field form showing reference points and any measurements to be used to locate sampling points. If offshore sites are selected, a GPS can be used to find latitude and longitude coordinates for sampling points. These coordinates will be recorded on a site sampling map or field form, and in the field logbook.

6.0 SEDIMENT SAMPLING EQUIPMENT

Sediment sampling devices will be selected based on depth to sediment, type of sediment, type and size of sample required. Shallow sediment samples can be collected by trowel, scoop or shovel, which is decontaminated before use and between use at each specific sampling location. Manual augering equipment (tube or bucket auger); manual coring devices with Teflon or acetate liners; or barge-mounted machine augering (e.g., hollow-stem) equipment can be used to collect samples. Dredging equipment can be used for larger samples including Peterson, Eckman, and Ponar dredges. Selected sediment sampling methods have been outlined below.

Additionally, a sediment sampling equipment selection table (Attachment A), which was adapted from Ohio EPA, Sediment Sampling Guide (Ohio EPA 2001) and USEPA SOP #2016 – Sediment Sampling provides (USEPA 1994), provides alternative information for selection and use of sediment sampling equipment. The Site-Specific Work Plan will specify the sampling equipment and method(s) to be used. Sampling equipment should be selected to minimize disturbance of potentially impacted sediments.

6.1 Shallow Sediment Sampling Methods

If the water is wadeable, a sediment sample may be collected by scooping the sediment using a stainless steel spoon or scoop, reducing the potential for cross-contamination. This can be accomplished by wading into the stream, and while facing upstream (into the current), scooping the sample along the stream bottom in the

upstream direction. If the stream is too deep to wade but less than eight feet deep, a stainless steel scoop attached to a piece of conduit can be used either from the banks if the stream is narrow or from a boat.

If the stream has a significant flow and is too deep to wade, a BMH-60 sampler may be used. It is not particularly efficient in mud or other soft substrates because its weight will cause penetration to deeper sediments, which are not desired when sampling for priority pollutants. It is also difficult to release secured samples in an undisturbed fashion that would readily permit sub-sampling. The BMH-60 may be used for priority pollutant sampling provided that caution is exercised by only taking sub-samples that have not been in contact with the metal walls of the sampler.

6.2 Core Sampling Methods

Core Sampling Methods are used to sample vertical columns of sediment. They are particularly useful when a historical approach to sediment deposition is desired for they preserve the sequential layering of the deposit. Many types of coring devices have been developed depending on the depth of water from which the sample is to be obtained, the nature of the bottom material, and the length of core to be collected. They vary from hand push tubes to weight or gravity driven devices.

Coring devices are particularly useful in pollutant monitoring because the "shock wave" created by descent is minimal, thus the fines of the sediment-water interface are only minimally disturbed; the sample is withdrawn intact permitting the removal of only those layers of interest; core liners manufactured of glass or Teflon® can be purchased, thus reducing possible sample contamination; and the samples are easily delivered to the lab for analysis in the tube in which they were collected. The disadvantage of coring devices is that a relatively small surface area and sample size is obtained often necessitating repetitive sampling in order to obtain the required amount for analysis. Because it is felt that this disadvantage is offset by the advantages, coring devices are recommended in sampling sediments for trace organic compounds or metals analyses.

Hand / Push Coring Devices may be used in shallow, wade-able waters. This method involves the direct use of a core liner or tube manufactured of Teflon® or glass is recommended for the collection of sediment samples. Their use can also be extended to deep waters when SCUBA equipment is available. Teflon® is preferred to avoid glass breakage and possible sample loss. Stainless steel push tubes are also acceptable and provide a better

cutting edge and higher strength than Teflon®. The use of the glass or Teflon® tube by itself eliminates any possible metal contamination from core barrels, cutting heads, and retainers. The tube should be approximately 12 inches if only recently deposited sediments (8 inches or less) are to be sampled. Longer tubes should be used when the depth of the substrate exceeds eight inches. Soft or semi-consolidated sediments such as mud and clays have a greater adherence to the inside of the tube and thus can be sampled with larger diameter tubes. Because coarse or unconsolidated sediments such as sands and gravel tend to fall out of the tube, a small diameter is required for them. A tube about two inches in diameter is usually the best size. The wall thickness of the tube should be about 1/3 inch for either Teflon® or glass. The inside wall may be filed down at the bottom of the tube to facilitate entry of the liner into the substrate.

Caution should be exercised not to disturb the area to be sampled when the sample is obtained by wading in shallow water. The core tube is pushed into the substrate until only four inches or less of the tube is above the sediment-water interface. When sampling hard or coarse substrates, a gentle rotation of the tube while it is pushed will facilitate greater penetration and cut down on core compaction. The tube is then capped with a Teflon® plug or a sheet of Teflon® held in place by a rubber stopper or cork. After capping, the tube is slowly extracted, the negative pressure and adherence of the sediment keeping the sample in the tube. Before pulling the bottom part of the core above the water surface, it too is capped. With a few modifications, this method can also be applied to sample collection from the edge of a boat or barge.

Vibro-core sampling is described as an electrical powered sediment sampling system featuring a vibrator head that drives a core tube liner into the sediment. Liners, often containing cellulose acetate butyrate (CAB), can be up to 20 feet (6 meters) long and 4 inch inside diameter (ID); lengths are selected based on sediment measured. The sampling vessel should be triple anchored, moored to a secure fixture, or spudded prior to collecting cores. The following procedure is a suggested method to collect sediment core samples:

1. Measure the water depth and soft sediment thickness.
2. Insert core catcher into CAB tube.
3. Position core catcher, drill holes, and rivet into place with aluminum rivets.
4. Lift the vibrating head with the winch to a vertical position so that it is suspended just off the bow of the sampling vessel.
5. Insert the core tube into the vibrating head, making sure that the tube slides in all the way.

6. Tighten the collar to the vibro-core (two bolts on each side).
7. Lower the entire assembly until the core nose is just above the sediment surface. Care should be taken to ensure that the cutter head or end of the core tube does not come into contact with the vessel during deployment. Verify that the generator is on. Turn on the vibrating head.
8. Slowly lower the vibro-core by running out 6-10 inches of cable at a time. Monitor core tube penetration by feeling for slack in the cable. Note appropriate rate of penetration in field log (Appendix B).
9. When the vibro-core ceases to penetrate the sediment (stops lowering or is "refused"), or the vibrating head is near the sediment surface, reverse the winch and pull the unit from the sediment. Do not allow the vibrating head to become imbedded into the sediment.
10. Turn off the power to the vibrating head when the core breaks free of the sediment.
11. During retrieval, the coring device and core tube need to be maintained in a vertical position to minimize disturbance of the collected sediments. Lift the assembly so that the sediment/water interface is visible. Wash the excess sediment from the outside of the tube. Once out of the water, the cutter head should be inspected and a physical description of the material at the mouth of the core entered into the core log. Drill holes through tube at the sediment/water interface and decant water from tube.
12. Tie line around tube in a single or double clove hitch.
13. Disengage the tube and lay the sediment core on the deck. Saw off excess core tube at the sediment surface, and cap the top of the tube with a red cap plug. Both ends should then be secured tightly with duct tape to prevent leakage. The amount of sediment in the tube should be measured and recorded in the sample log, along with the overall condition of the core. The core tube then should be marked to denote: Location, Recovery Length, Top of Core, Date, and Time.
14. Handle and sub-sample core as desired, on board, or at a shore based location.

Ogeechee / Open Barrel Punch Corer. The core unit will be deployed from the sampling vessel by hand to collect an undisturbed sediment sample to a depth of approximately 4 feet below the sediment/surface water interface. The open barrel punch-core will be manned by a minimum of two crewmembers: one staff member or contractor will handle the deployment and retrieval of the core while the vessel operator controls the boat and records the sampling location.

1. Make field notes and logbook entries as necessary throughout the sampling process to ensure thorough and accurate record keeping.
2. Maneuver the boat to the sampling location as identified in the project SSWP or based on field encountered conditions/data.
3. Measure and record the depth to sediment and sediment thickness using poling methods. This information will be used for comparison with any hydrographic survey results.
4. Place the liner (thin-walled tube) inside the core-barrel sampler followed by the core catcher. Open the check valve located atop the core unit. Attach lengths of rod to the core unit to enable the operator to push the core down to the appropriate depth. The rods also allow for the use of weights to help drive the core if needed.
5. Guide the core overboard.
6. Lower the core to the sediment surface at approximately 1.0 feet per second (ft/sec) so as to minimize sediment surface disturbances.
7. Record the location of the boat when sampler reaches bottom.
8. Push or use the weights to drive the sampler to the depth specified in the SSWP or based on field encountered conditions/data.
9. Close the check valve on the barrel core sampler and begin retrieving the sampler, raising it at approximately 1.0 ft/sec.
10. Guide the core on board the vessel and place it on the worktable on the deck; use care to avoid jostling that might disturb the integrity of the sample. Remove the core liner from the barrel.
11. Examine the sample for the following sediment acceptance criteria:
    - The sampler is not overfilled so that the sediment is present in the retrieval rods;
    - No leakage has occurred, as indicated by the presence of sediment at the end of the core tube;
    - No sample disturbance has occurred, as indicated by limited turbidity in the overlying water;
    - If sample acceptance criteria are not achieved, the sample will be rejected and the location re-sampled. If unable to obtain a sample that meets the appropriate acceptance criteria within 50 feet of the proposed location, the sample will be relocated as determined by the Project Manager or Task Manager, as appropriate.
12. Decant or siphon off free water from the surface of the sediment. Care should be taken to not disturb the integrity of the sediment surface. Extrude the sediment from the core liner.

13. Visually classify sediment, record the descriptions on the sediment sampling form, and photograph sample.
14. Repeat the sampling process (if necessary) until sufficient volume is obtained to satisfy the sampling requirements for each location. Collect successive core samples within a radius of 10 feet of the initial sampling location.
15. Handle and sub-sample core as desired, on board, or at a shore based location.

6.3 Dredge Sampling Methods

The Peterson dredge can be used when the bottom is rocky, in very deep water, or when the stream velocity is high. The dredge should be lowered very slowly as it approaches bottom, because it can displace and miss lighter materials if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high velocities. It should not be used from a bridge more than a few feet above the water, because the spring mechanism which activates the sampler can be damaged by the messenger if dropped from too great a height.

The Ponar dredge is a modification of the Peterson dredge and is similar in size and weight. It has been modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing the "shock wave." The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates.

1. Make field notes and logbook entries as necessary throughout the sampling process to ensure thorough and accurate record keeping.
2. Maneuver the boat to the sampling location as identified in the SSWP or based on field encountered conditions/data.
3. Measure and record the depth to sediment and sediment thickness using the poling methods. This information will be used for comparison with any hydrographic survey results.
4. Open the sampler and slide the locking pin into place.

5. Guide the sampler overboard.
6. Lower the sampler to the sediment surface at approximately 1.0 feet per second (ft/sec).
7. Record the location of the boat when sampler reaches bottom.
8. Begin retrieving the sampler and raise it at approximately 1.0 ft/sec.
9. Guide the sampler on board the vessel and place it on the worktable on the deck; use care to avoid jostling that might disturb the integrity of the sample.
10. Examine the sample for the following sediment acceptance criteria:
    - Sampler jaw is closed and the sample does not contain foreign objects
    - Desired penetration depth has been achieved
    - The sampler is not overfilled so that the sediment surface presses against the top of the sampler
    - No leakage has occurred, as indicated by overlying water on the sediment surface
    - No sample disturbance has occurred, as indicated by limited turbidity in the overlying water
    - No winnowing has occurred, as indicated by a relatively flat undisturbed surface
    - If sample acceptance criteria are not achieved, the sample will be rejected and the location re-sampled. If unable to obtain a sample that meets the appropriate acceptance criteria within 50 feet of the proposed location, the sample will be relocated as determined by the Project Manager or Task Manager, as appropriate.
11. Decant or siphon off free water from the surface of the sediment. Care should be taken to not disturb the integrity of the sediment surface.
12. Visually classify sediment, record the descriptions on a sediment sampling form, and photograph sample.
13. Collect the sediment from the sampler using a stainless steel implement and care not to include any material that has been in contact with any interior sampler surface. Place this sediment into an appropriate-sized stainless steel homogenization bowl.
14. Thoroughly rinse the interior of the sampler until all loose sediment has been washed off.
15. Repeat the sampling process (if necessary) until sufficient volume is obtained to satisfy the sampling requirements for each location. Collect successive grab samples within a radius of 10 feet of the initial sampling location.
16. Homogenize the bulk sediment until it has uniform color and texture.
17. Place samples into containers in accordance with SSWP.

18. Clean the exterior of all sample containers and store them in a cooler with ice.

7.0 SAMPLE COLLECTION PROCEDURES

- Prior to mobilization to the field, consult with the contracted analytical laboratory to ascertain if they require any sediment-specific sample collection procedures to be followed to ensure that samples are acceptable for the analyses to be conducted and provided in adequate volume for analyses.
- Sampling locations will be located horizontally using a Global Positioning System (GPS) receiver in the field. Either Real Time Kinematic (RTK), or Differential GPS (DGPS) may be used to achieve sub-foot accuracy.
- Sampling locations will be estimated vertically using a graduated pole in combination with site staff gauge. If a staff gauge has not been established at the site, a staff gauge shall be established and surveyed accurate to ±0.01 feet. Prior to sample collection, a graduated pole will be used to measure the top of sediment relative to surface water. The estimated elevation each sediment sample will be calculated in the office using the surface water elevations measured from the site staff gauge. Measurements shall be collected from the site staff gauge multiple times throughout each day of sampling to account for fluctuating water levels.
- Using a decontaminated sampling instrument, remove the desired thickness and volume of sediment from the sampling location.
- When coring sediments, the penetration depth, recovery depth, and percent recovery shall be recorded on a sediment sampling field form (Appendix B)
- If sediment is not saturated, conduct a direct screening of the sample with a photoionization detector (PID).
- Describe and classify the sample in accordance with SOP ENV-07-02, Description and Classification of Sediments and record observations on a sediment sampling field form (Appendix B).
- **Volatile Organic Compounds (VOCs) –** Discrete sediment samples for VOC analyses will be collected as soon after sample retrieval as possible. Any surface water should be decanted from the sediment before collecting the samples. Pre-preserved vials or jars with Teflon-lined lids will be used if moisture content of soil is too high to allow collection of 5-gram samples for vials. Attachment B provides a detailed sampling procedure for pre-preserved vials. If jars are used, they will be filled to provide zero-headspace samples. Secure container lid, apply label containing sample identification information and place in cooler with ice.

- **Semivolatile Organic Compounds (SVOCs), Metals, Cyanide, PCBs, Pesticides, Herbicides, and Organic Carbon –** Sediment samples for these analytes will be collected after collecting VOCs. Any surface water should be decanted from the sediment before placing it in a container for homogenization. Samples will be homogenized using clean stainless steel mixing bowls, spoons, knifes, etc. Sample aliquots will be placed directly from the sample retrieval device into the stainless steel bowl. The soil will be thoroughly mixed in the bowl to homogenize the sample and then placed directly into appropriate sample containers. Secure container lid, apply label containing sample identification information and place in cooler with ice.
- **Physical Characteristics –** Sediment samples collected for physical characterization should be carefully placed into a large glass jar directly from the sampler to mitigate sample disturbance. Secure container lid, apply label containing sample identification information and place in transportation container.
- Samples shall be identified, labeled, logged, stored and prepared for shipment in accordance with SOP ENV-03-01, Sample Labeling, Logging, Storage and Shipment.
- SOP ENV-03-02 Chain-of-Custody procedures shall be followed in preparing the samples for transport to the analytical laboratory.
- Sampling equipment and tools shall be decontaminated between each sample in accordance with SOP ENV-04-04.
- Containerize any investigation-derived solid and liquid waste, including decontamination water, label and store for disposal at an appropriate disposal facility. Consult with Project Manager regarding disposal of waste.

8.0 DOCUMENTATION

Sampling activities shall be documented as outline in SOP ENV-01-01 and as specified the Site-Specific Work Plan. Visual observations are particularly important and may prove invaluable in interpreting sediment quality study results. Visual observations of affected sediment will use the descriptors from SOP ENV-05-02, Attachment E. These visual observations, including weather and water body conditions during the sampling event, shall also be recorded in the field logbook and/or on the appropriate field form (Appendix B).

9.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2003, D3975-93(2003) Standard Practice for Development and Use (Preparation) of Samples for Collaborative Testing of Methods for Analysis of Sediments.

ASTM International, 2005, D3976-92(2005) Standard Practice for Preparation of Sediment Samples for Chemical Analysis.

ASTM International, 2003, D4823-95(2003)e01 Guide for Core Sampling Submerged, Unconsolidated Sediments.

Ohio Environmental Protection Agency, Division of Surface Water, 2001, Sediment and Sampling Guide and Methodologies, 2nd Ed., November.

USEPA Region V, 1984, Methods Manual for Bottom Sediment Sample Collection, EPA-905-4-004, May.

USEPA, 1994, SOP #2016 – Sediment Sampling, November 17.

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

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ATTACHMENT A
SEDIMENT SAMPLING EQUIPMENT SELECTION TABLE

Author: C. Barry **Q2R & Approval By:** J. Gonzalez **Q3R & Approval By:** M. Kelley

SEDIMENT SAMPLING EQUIPMENT SELECTION TABLE[1,2]

Sample Type	Model	Current	Substrate	Remarks
GRAB	Spoon Scoop	Zero To Slight	All	• Use only in relatively calm and shallow water • Relatively little sample disturbance • Simple and inexpensive • Fines may washout when retrieved through water column
CORE	Tube Auger	Zero To Slight	Clay and Silt	• Use only in relatively calm and shallow water • Extension handles can be used for deeper waters. • Relatively little sample disturbance • Simple and inexpensive • Fines may washout when retrieved through water column
CORE	Bucket Auger	Zero To Slight	Clay to Fine Gravel	• Use only in relatively calm and shallow water • Extension handles can be used for deeper waters. • Relatively little sample disturbance • Simple and inexpensive • Fines may washout when retrieved through water column
GRAB	Eckman	Zero To Very Slight	Clay and Silt	• Use in relatively calm water • Pebbles and branches may interfere with jaw closure • Excellent jaw shape and cut • Relatively little sample disturbance • Poor stability – Light weight allows for tendency to "swim" in a current, which sometimes causes miss triggers • 0.02 square meter sample area • Weight with sample is 10 kilograms

[1] Ohio Environmental Protection Agency, Division of Surface Water, 2001, Sediment and Sampling Guide and Methodologies, 2nd Ed., November.
[2] USEPA, 1994, SOP #2016 – Sediment Sampling, November 17.

SEDIMENT SAMPLING EQUIPMENT SELECTION TABLE[1,2] (Continued)

Sample Type	Model	Current	Substrate	Remarks
GRAB	Petite Ponar Peterson	Zero To Very Slight	Clay to Fine Gravel	• Needs relatively calm/sheltered waters • Good stability • Poor jaw shape and cut • Sample disturbance • Less washout if extra weights are used • More cumbersome than an Eckman – Requires a winch • 0.1 – 0.2 square meter sample area • Weight with sample is 30 – 50 kilograms
CORE	Manual	Zero To Strong	Clay to Sand (Inserts needed for sandy samples)	• Recommended for use in shallow water • Deployed by hand or driver (hammer) • Extension handles can be used for deeper waters.
CORE	Coring Tubes	Zero To Moderate	Clay to Sand (Inserts needed for sandy samples)	• Quick and easy • Relatively undisturbed sample • Small sample volume • Samples sometimes compressed
CORE	Gravity	Zero To Moderate	Clay and Silt	• Recommended for rivers • Depths up to 10 meters
CORE	Split Spoon	Zero To Moderate	Clay to Sand (Inserts needed for sandy samples)	• Recommended for use in shallow water • Deployed by hand or driver (hammer) • Vertical profile remains intact and is visible • Point design can reduce sample compaction • Stones can interfere with collection • Equipment is heavy

[1] Ohio Environmental Protection Agency, Division of Surface Water, 2001, Sediment and Sampling Guide and Methodologies, 2nd Ed., November.
[2] USEPA, 1994, SOP #2016 – Sediment Sampling, November 17.

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ATTACHMENT B
ENCORE AND POWERSTOP SAMPLING PROCEDURES

Author:	C. Barry	Q2R & Approval By:	J. Gonzalez	Q3R & Approval By:	M. Kelley

ENCORE™ SOIL SAMPLING PROCEDURE

- Remove EnCore™ sampler and cap from its re-sealable pouch and attach T-handle to sampler body. (**Note**: when dealing with soft or sandy solid, it may be necessary to retract the plunger in the sampler before sample collection.)

- Using the T-handle for leverage, push the sampler into a freshly exposed surface of sediment until the sampler is full.

- Brush any soil off the sampler head and securely attach the sampler cap by pushing with a twisting motion.

- Complete the sample label and attach to the sampler body; place labeled sampler in its re-sealable pouch and seal the pouch.

- Repeat the procedure for two additional samples collected from the same soil stratum or the same area. (**Note:** this step may be eliminated or the number of samples reduced if the suspected level of VOCs is known [i.e., low or high concentration sample]. Consult Method 5035 or discuss procedure with an analytical laboratory for further details.)

- Use a stainless steel spoon or similar tool to collect an additional sample from the same sediment stratum or the same area. Place collected material in a 2-ounce, wide-mouth jar with no preservatives. (**Note:** this additional soil volume is for dry weight and percent moisture determination. This step is not necessary if additional soil from the sample location is collected for other parameter analyses upon which dry weight and percent moisture will be determined.)

- Immediately place samples in a cooler with ice.

  Ship EnCore™ samples (next day priority delivery) to the contract laboratory the day they are collected. Alternatively, arrange to have samples picked-up by the laboratory or delivered to the laboratory by field

personnel within 24 hours of collection. These sample shipment or pickup timelines must be achieved to ensure the laboratory performs sample preservation or analysis within 48 hours of sample collection.

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POWERSTOP HANDLE SAMPLING PROCEDURE

1. Load Sampling Device

Insert EasyDraw Syringe™ into the appropriate slot (5 or 10-gram heavy, 5 or 10-gram medium, 5 or 10-gram light or 13 gram position) on the Powerstop Handle™ device and remove end cap from syringe.

EPA Method 5035 Recommended 5-gram slot positions:

- Use the heavy position for dense clay;
- Use the light position for dry sandy soil; and
- Use the medium position for all others.

2. Collect Sample

Push EasyDraw Syringe™ into a freshly exposed surface of soil until the syringe is full. Continue pushing until the soil column inside the syringe has forced the plunger to the stopping pint. (**Note**: unlike other sample collection devices, there is no headspace air in the syringe to displace.) EasyDraw Syringe™ delivers approximately 5, 10, or 13 grams. Actual weight will be determined at the laboratory. No scale or balance required in the field.

3. Eject Sample Into Vial

Remove the syringe from the Powerstop Handle™ device and insert the syringe into the open end of 40-ml vial, and eject sample into pre-tared vial by pushing on the syringe plunger. Avoid getting dirt on the threads of the 40-ml vial. Cap vial immediately and put on ice. Sample must be received by within 48 hours of sampling if samples are not chemically preserved in the field.

SOP SERIES SAS-08

GROUNDWATER SAMPLING AND MEASUREMENT PROCEDURES

STANDARD OPERATING PROCEDURE NO. SAS-08-01

GROUNDWATER AND NON-AQUEOUS PHASE LIQUID MEASUREMENT Revision 1

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe method(s) to measure groundwater, Light Non-Aqueous Phase Liquids (LNAPL) and Dense Non-Aqueous Phase Liquids (DNAPL) elevations and thicknesses in groundwater monitoring wells, observation wells, and recovery wells as required in the Site-Specific Work Plan or as otherwise specified.

2.0 EQUIPMENT AND MATERIALS

- Notebook, field logbook, and/or the field activity form;
- Steel add-on tape or electronic water level indicator;
- Electronic water level indicator;
- Electronic oil/water interface probe;
- Pressure transducer (as appropriate for the conditions);
- Gasket adapted to the diameter of the transducer cable;
- Data logger;
- Decontamination equipment and supplies (in accordance with the guidelines in SOP ENV-04-05).
- Personal protective equipment; and
- Chalk

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read

and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 GENERAL REQUIREMENTS

Water level, LNAPL, and DNAPL (if present) measurements should be obtained at wells designated in the Site-Specific Work Plan. Water level, LNAPL, and DNAPL levels should be measured in referenced to a common elevation or datum, preferably to a USGS benchmark located at the site. Water level, LNAPL, and DNAPL depths should be measured from a reference point marked on the top of the casing, which, in turn, is referenced to a permanent benchmark.

Water and product level measurement devices shall be decontaminated as per SOP ENV-04-05 or as specified in the Site-Specific Work Plan before and after measuring at each location.

Care shall be exercised to avoid direct skin contact while measuring water level and product depth. All equipment should be decontaminated before and after each measurement as per SOP ENV-04-05. Water and product level measurements should be recorded in the field logbook and/or the field activity form.

5.0 MEASUREMENT METHODS AND PROCEDURES

5.1 Discrete Groundwater Level Measurement

Discrete water level measurements should be made by determining the depth to the water surface from the top of the well casing at the fixed reference point. The fixed reference point is established by permanently marking a point on the outer edge (lip) of the well casing. Caution should be exercised so that filings do not fall into the well.

The depth to water can be determined using a steel add-on tape or electronic water level indicator. The steel add-on tape consists of a measuring tape that has 1-foot increments and a 1-foot section at the end of the tape with 0.01-foot increments. The end of the tape is coated with chalk and lowered into the well. The water depth is read from the saturated mark on the chalked tape and added to the depth interval measured at the top of the well casing

Electronic water level indicators are conducting probes that activate an alarm and a light when they intersect the water. The sounder wire is marked in 0.01-foot intervals to indicate depth. All sounders are equipped with weights to maintain line tension for accurate readings. The typical operating procedures for an electronic water level indicator are as follows:

- Lower the sounder wire until it just makes contact with the water in the well and the indicator light goes on or the pulsating alarm is sounded. Record the position of the wire relative to the reference point at the top of the well casing. Record the actual water level reading to the nearest 0.01-foot. Repeat to confirm depth.
- Withdraw the sounder from the well.
- Record the water depth in the field logbook and/or the field activity form.
- Decontaminate the sounder wire and electrode in accordance with SOP ENV-04-05.

Discrete water levels are typically required from a series of wells when data for preparing groundwater contour maps are needed. However, discrete water levels may also be required when monitoring the changes in water level during aquifer testing if aquifer response is sufficiently slow. Continuous water level measurements are discussed in Section 5.4 of this SOP.

5.2 Discrete LNAPL Level Measurement

Discrete LNAPL or product level measurements should be made by determining the depth to the product and water surface from the top of the well casing at the fixed reference point. The fixed reference point is established by permanently marking a point on the outer edge (lip) of the well casing. Caution should be exercised so that filings do not fall into the well.

The depth of the product and water level may be obtained using an electronic oil/water interface probe. An oil/water interface probe has a multi-conducting probe that activates different signals, typically pulsating beeps and continuous alarms, when they intersect the product and water, respectively. The sounder wire is marked in 0.01-foot increments to indicate depth. The interface probe is equipped with a weight to maintain line tension and obtain accurate readings. The typical operating procedures for an electronic oil/water interface probe are as follows:

- Check the interface probe battery by pressing the test button to ensure the device is operating properly before and after taking the level measurement. Daily battery checks should also be made and documented in the logbook.
- Lower the interface probe until it makes contact with the product in the well and the product indicator light goes on or the continuous alarm is sounded. Record the position of the wire relative to the reference point to the nearest 0.01-foot. Repeat to confirm the depth of the product.
- Continue to lower the interface probe, through the product layer, until it makes contact with the water level in the well and the water indicator light goes on or the pulsating alarm is sounded. Record the position of the wire to the reference point to the nearest 0.01-foot. Repeat to confirm the depth of the water.
- Withdraw the probe from the well.
- Record the product and water depth in the field logbook and/or the field activity form.
- Decontaminate the sounder wire and probe in accordance with the guidelines in SOP ENV-04-05.

Alternatively, the depth to the top of LNAPL may be approximated to the tenth of an inch with a weighted standard measuring tape. The thickness of LNAPL will be approximated using a bottom filling, clear, disposable bailer. The bailer may be slowly lowered into the water column, just below the approximate surface and allowed to fill. The bailer will be gently removed from the well to minimize disturbance. Measurements of the observed thickness of LNAPL will be measured to the nearest 0.1-foot using a standard measuring tape and recorded in the field logbook and/or the field activity form.

5.3 Discrete DNAPL Level Measurement

Discrete DNAPL or product level measurements should be made by determining the depth to the product and water surface from the top of the well casing at the fixed reference point. The fixed reference point is established by permanently marking a point on the outer edge (lip) of the well casing. Caution should be exercised so that filings do not fall into the well.

The depth of the water and product level may be obtained using an electronic oil/water interface probe. An oil/water interface probe has a multi-conducting probe that activates different signals, typically continuous alarms and pulsating beeps, when they intersect the water and product, respectively. The sounder wire is

marked in 0.01-foot increments to indicate depth. The interface probe is equipped with a weight to maintain line tension and obtain accurate readings. The typical operating procedures for an electronic oil/water interface probe are as follows:

- Check the interface probe battery by pressing the test button to ensure the device is operating properly before and after taking the level measurement. Daily battery checks should also be made and documented in the logbook.
- Lower the interface probe until it makes contact with the water in the well and the water indicator light goes on or the beeping alarm is sounded. Record the position of the wire relative to the reference point to the nearest 0.01-foot. Repeat to confirm the depth of the water.
- Continue to lower the interface probe, through the water, until it makes contact with the product level in the well and the product indicator light goes on or the continuous alarm is sounded. Record the position of the wire to the reference point to the nearest 0.01-foot. Repeat to confirm the depth to the product.
- Withdraw the probe from the well.
- Record the water and product depth in the field logbook and/or the field activity form.
- Decontaminate the sounder wire and probe in accordance with the guidelines in SOP ENV-04-05.

Alternatively, the measurements of DNAPL may be approximated using a bottom filling, clear, disposable bailer. The bailer may be slowly lowered into the water column, to the bottom of the well and allowed to fill. The bailer will be gently removed from the well to minimize disturbance. Measurements of the observed thickness of DNAPL will be measured to the nearest 0.1-foot using a standard measuring tape and recorded in the field logbook and/or the field activity form.

5.4 Continuous Water Level Measurement

Continuous water level measurements are made by determining the height of the water column above a pressure transducer and electronically recording fluctuations in this height with a data logger. The continuous recording of height of water above the transducer is used for aquifer testing where rapid changes in water level are anticipated. The typical operating procedures for a continuous water level system are as follows:

- Enter the program into a data logger that has fully charged batteries. Alkaline batteries are preferred. During use, the battery voltage should not drop below the minimum voltage specified by the manufacturer; damage to the data logger and loss of recorded data could result.

- Select a pressure transducer for use in a given well that is compatible with both water quality and anticipated pressure sensitivity range (i.e., 5 psi, 30 psi, etc.). The pressure range selected is dictated by the anticipated range in the water column above the transducer and by the desired precision in measurement.
- Connect the transducers to the data logger in the field following manufacturer's instructions. Typically, four to eight input channels are available on the system. Other factors affecting the sampling configuration include cable length; distance between monitored wells; terrain; local human activities (traffic, plant operations); and the ability to secure the system from weather and vandals.
- Attach the transducer cable to the data logger and calibrate in air according to manufacturer's instructions. If multiple data loggers are used, internal clock synchronization should also be performed.
- Measure water level and depth to the bottom of the well before lowering the transducer into the well. Water levels are measured with an electrical water level indicator; total depth of the well is measured with a device compatible with well depth.
- Secure a sanitary fitting (commonly a gasket adapted to the cable diameter) at the surface of the well. Lower transducer into the well through the sanitary fitting to a depth between the water level and the bottom of the well. The transducer must be kept submerged during the period of measurement. Take care to keep the piezometric crystal at the tip of the transducer out of any fine sediment that has accumulated in the bottom of the well. On some transducers, the crystal is protected from sediment intrusion. Measure water level again; record the time indicated on the data logger digital display and water level. From these readings (and other periodic manual water level measurements), the water levels can be converted to elevations.
- Transfer data stored in the data logger periodically to a portable computer. The frequency of data transfer depends on available memory and conditions encountered in the field. Data may be transferred as frequently as daily. If the data logger has a wrap-around memory, the information should be transferred so that records are not recorded over.

6.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

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STANDARD OPERATING PROCEDURE NO. SAS-08-02

LOW-FLOW GROUNDWATER SAMPLING Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures and guidelines for conducting low-flow groundwater sampling. This SOP provides a method that minimizes the impact of the purging process on groundwater chemistry and volume of water for disposal.

2.0 EQUIPMENT AND MATERIALS

- Map of well locations;
- Well construction information;
- Tools and well keys, as required to facilitate access to wells;
- Water level measuring device (electronic water level indicator, interface probe, or weighted steel tape);
- Adjustable rate peristaltic pump or an adjustable rate low-flow submersible or positive displacement bladder pump (Note: The Site-Specific Work and/or Field Sampling Plan (FSP) shall specify the type of pump required);
- 1/4 to 3/8-inch Teflon®, polyvinyl chloride (PVC), or polypropylene tubing;
- Flow measurement supplies (e.g. graduated cylinder and stop watch);
- Power source, if applicable;
- Compressed inert gas source (for use with bladder pump), if applicable;
- Flow-through cell;
- Groundwater quality/indicator parameter monitoring instruments (flow-through cell capable);
- Instrument operation manual(s);
- Instrument calibration standard(s);
- Container(s) for purge water storage (e.g. 5-gallon buckets, polyethylene storage tank, etc.);
- Sample containers and labels, as appropriate for the analytical method(s) selected;
- Field filtration equipment, if applicable;

- Chain of custody forms and seals;
- Cooler(s) with double-bagged ice;
- Polyethylene sheeting, as appropriate;
- Decontamination materials;
- Personal protection equipment; and
- Field logbook and/or appropriate field form.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 APPLICATION OF SAMPLING METHOD

Low-flow is one of several acceptable sampling procedures and may be performed using bladder or peristaltic pumps. Peristaltic pumps may be used when the well depth is less than or equal to fifteen feet, in zones of high contamination, or as approved in a SSWP. The sampling method may be modified to demonstrate attainment of cleanup goals in the future. Low-flow sampling shall not be used when one or more of the following conditions are present:

- Well will not accept or allow placement of the sampling device;
- Non-aqueous phase liquids (NAPLs). Reference SOP SAS-08-07 when sampling wells with NAPL;
- Formation screened will not allow drawdown to stabilize; and
- Water column is less than 2 feet in height.

5.0 EXECUTION

To the extent practical, sampling shall begin at the monitoring well with the least contamination and proceed systematically to the monitoring wells with the most contamination using the procedure outlined in the following subsections unless otherwise required by the Site-Specific Work and/or FSPs.

5.1 Preparation

The sampler shall create a work area around the monitoring well to minimize the potential for cross-contamination. Work area preparations may include the placement of polyethylene sheeting prevent sampling equipment from coming in contact with the ground surface. The sampler shall barricade and/or flag the work area, if required by the Site-Specific HASP. The sampler shall also arrange the sampling equipment and supplies to facilitate efficient execution of groundwater sampling procedures.

5.2 Well Gauging

Groundwater and NAPL, if present, elevation measurements shall be obtained in accordance with SOP SAS-08-01 or as otherwise specified in the Site-Specific Work and/or FSPs. Following sampling, the sampler may obtain the total well depth from top of casing (in feet to the nearest 0.01-foot) using a water level indicator, interface probe, or steel tape, as detailed in SOP SAS-08-05 and as required by the Site-Specific Work and/or FSP or otherwise specified. Measuring the total well depth prior to sampling should be avoided. Total well depths may be obtained following sampling activities or at least two weeks prior to the sampling. If total well depth is required to be measured immediately prior to sampling, the sampler will take precautions to minimize the displacement of sediments, if present, within the well during gauging activities. In general, the use of an interface probe shall be limited to wells containing NAPL or elevated concentrations of constituents of concern. Groundwater and NAPL elevation measurements and total well depth measurements shall be recorded in the field logbook and/or on the appropriate field form.

5.3 Pump/Tubing Intake Positioning

The sampler should determine and place or position the pump/tubing intake as appropriate relative to the position of the water level, screened interval, and constituents of concern. The position the pump/tubing intake should be a minimum of one foot above the well sump to the extent practical and preferably at an elevation near the center of the well screen. The sampler shall slowly raise or lower the pump or tubing when

placing or positioning intake in order to minimize the displacement of sediments, if present, within the well. The pump model/type, tubing (type, inner diameter, and length), and pump/tubing intake depth/elevation shall be recorded in the field logbook and/or on the appropriate field form. If the water quality instruments can be programmed to calculate the one tubing volume, the data collected during pump/tubing intake placement/positioning shall be entered into the instrument. If the instrument cannot be programmed to calculate the tubing volume, this volume shall be calculated by the sampler using the following formula.

$$\text{Tubing Volume}_{(\text{Gallons})} = \text{Tubing Length}_{(\text{Feet})} \times \text{Volume per One Foot of Tubing}^{TDS}_{(\text{Gallons/Foot})}$$

Where: ^{TDS} = Tubing inner diameter-specific; tubing manufacturer provided information.

The calculated tubing volume shall also be recorded in the field logbook and/or on the appropriate field form.

5.4 Equipment Assembly and Calibration

The sampler shall connect the tubing from the well to the inflow fitting at the bottom of the flow-through cell. A length of tubing shall be connected to the outflow fitting at the top of the flow-through cell with the other end extending into a 5-gallon bucket. The 5-gallon bucket shall be used to collect the purge water. Groundwater quality/indicator parameter monitoring instruments will be calibrated in accordance with the instrument operation manual(s) and SOP SAS-02-01 using the manufacturer prescribed calibration standards. During instrument calibration, the instrument shall be set up to measure and record data in the units (e.g. microsiemens per centimeter (uS/cm), milligrams per liter (mg/L), etc.) specified in the Site-Specific Work and/or Sampling Plan(s). Calibration shall be documented in the field logbook and/or on the appropriated field form. Following calibration, the instruments shall be connected to the flow-through cell.

5.5 Flow Rate and Drawdown Determination

The sampler shall re-gauge the depth to groundwater from the top of well casing. The sampler shall turn on the pump at its lowest setting and determine the flow rate by measuring the volume of water removed over a one-minute period using a graduated cylinder and stop watch or other approved flow rate measuring device. The sampler shall monitor the water column drawdown and shall adjust the pump to avoid a drawdown of more than 0.1 meter or 0.3 feet (4 inches). The flow rate of the pump shall generally be adjusted to between 0.2 and 0.5 liters per minute (L/min). During pump start-up, drawdown may exceed 0.3 feet provided the drawdown stabilizes and the groundwater level does not fall below the intake level. The water level shall not

fall below the top of the well screen if the water level was greater than 0.5 feet above the well screen prior to commencing pumping activities. Pump adjustments shall be made within the first 15 minutes of purging. The final flow rate and stabilized drawdown shall be recorded in the field logbook and/or on the appropriated field form.

5.6 Purging and Groundwater Quality/Indicator Parameter Monitoring

The Site-Specific Work and/or FSPs shall specify the groundwater quality/indicator parameters to be monitored, which typically include temperature, pH, specific conductance or actual conductivity, oxidation-reduction potential, dissolved oxygen, and turbidity. Parameter monitoring will begin after a minimum of tubing volume has been purged from the well. The sampler shall monitor and record in the field logbook and/or on the appropriate field form parameters every three to five minutes (during continuous purging) until parameters have stabilized. A generic groundwater sampling field form is provided in Appendix B. Five-minute intervals are typical; three-minute intervals are used during flow rates in highly permeable media that will allow pumping rates that exceed typical low-flow rates. Parameter stabilization is considered to be achieved when three consecutive readings, spaced approximately 2 to 10 minutes, or 0.5 well volumes or more apart, are within the parameter-specific limit listed in the table below or as specified in the Site-Specific Work and/or Sampling Plan(s).

Parameter	**Stabilization Criteria**[1]
Conductance, Specific Electrical	+/- 3% µS/cm @ 25°C
Conductivity, Actual[2]	+/- 3% µS/cm
Dissolved Oxygen	+/- 0.3 mg/L
Oxidation-Reduction Potential	+/- 10 mV
pH	+/- 0.1 standard units
Temperature	+/- 0.1 °C
Turbidity	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs and/or visually clear water

[1] USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA 542-S-02-001
[2] Based on the stabilization criteria for specific electrical conductance as published in the documented cited above

Once the parameters have stabilized, purging is considered complete and sample collection shall commence.

5.7 Sample Collection

While water is being purged from the well, groundwater samples shall be collected directly into the laboratory provided sample containers from the tubing, before the water has passed through the flow-through cell. This shall be accomplished by using a by-pass assemble or disconnecting the flow-through cell to obtain the sample. Water collected for analysis requiring field filtration will be filtered with an in-line Nalgene© disposable 0.45 micron (µm) filter, or equivalent. Water will be discharged directly from the in-line filter into the sample container following a filter pre-rinse, which will be performed by passing water through the filter, minimum of 500 milliliter (mL), and discharging prior to collection of the sample(s). Samples collected with bailers will be collected in intermediated unpreserved laboratory-provided containers and immediately field filtered as previous described with in-line filters.

Samples shall be collected in order of analyte stability, as summarized below, unless otherwise specified by the Site-Specific Work and/or FSPs:

- Volatile organic compounds (VOCs);
- Semi-volatile organic compounds (SVOCs);
- Non-filtered, non-preserved samples (e.g. PCBs, sulfate, etc.);
- Non-filtered, preserved samples (e.g. phenols, nitrogen, cyanide, total metals, etc.);
- Filtered, non-preserved samples;
- Filtered, preserved samples (e.g. dissolved metals); and
- Miscellaneous parameters.

Quality Control (QC) samples, if required, will be collected consecutively to ensure appropriate duplicate sample collection in accordance with SOP SAS-04-03. Immediately following collection, samples shall be placed in an iced cooler.

5.8 Post-Sample Collection

Non-Dedicated and dedicated sampling equipment, which does not remain within the well casing, shall be removed from the monitoring well. The reusable and/or dedicated equipment and instruments shall be decontaminated in accordance with SOP SAS-04-04 or as otherwise specified by the Site-Specific Work and/or Sampling Plan(s). Disposable equipment and supplies shall be disposed of in accordance with procedures outlined in the Site-Specific Work and/or FSPs. The sampler shall secure the well casing using a slip or expandable well cap. The flush-mount lid shall be bolted down or the protective cover closed and locked, as appropriate.

6.0 DOCUMENTATION

Sample information, labeling, and custody control shall be performed in accordance with requirements specified in SOP SAS-03-01 and SAS-03-02. Sampling activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP SAS-01-01 or as required by the Site-Specific Work and/or FSPs. A generic groundwater sampling field form is provided in Appendix B.

7.0 REFERENCES AND ADDITIONAL RESOURCES

USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Manager, Region 5 and Region 10, EPA 542-S-02-001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-08-03

WELL-VOLUME APPROACH GROUNDWATER SAMPLING Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for obtaining groundwater samples using the well-volume approach from groundwater monitoring wells, recovery wells, or observation wells as described in the Site-Specific Work Plan or as otherwise specified for the purpose of determining groundwater quality. The well-volume approach involves the purging of the stagnant water within the well and stabilization of water quality indicator parameters prior to sampling.

2.0 EQUIPMENT AND MATERIALS

- Map of well locations;
- Tools and well keys, as required to facilitate access to wells;
- Water level measuring device (e.g. electronic water level indicator, interface probe, or weight steel tape);
- Well construction information, as appropriate;
- Calculator / Conversion Chart
- Pump, if required by the Site-Specific Work and/or Field Sampling Plan (FSP);
- Teflon®, polyvinyl chloride (PVC), or polypropylene pump-specific tubing, if applicable;
- Power Source, if applicable;
- Bailer – Disposable (disposable for purging and sampling), PVC (for purging only), and/or stainless steel (for purging and/or sample collection), if required by the Site-Specific Work and/or FSP;
- Rope, if applicable;
- Disposable plastic cups or stainless steel cup;
- Groundwater quality/indictor parameter monitoring instruments;
- Instrument operation manual(s);
- Instrument calibration standard(s);

- Container(s) for purge water volume measurements and storage (e.g. 5-gallon bucket, polyethylene storage tank, etc.);
- Sample containers and labels, as appropriate for the analytical method(s) selected;
- Field filtration equipment, if applicable;
- Chain of custody forms and seals;
- Cooler(s) with double-bagged ice;
- Polyethylene sheeting, as appropriate;
- Personal protective equipment;
- Decontamination materials and supplies;
- Field logbook and/or appropriate field form; and

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 APPLICATION

The well-volume approach is one of several acceptable sampling procedures. The well-volume approach involves the purging of the stagnant water within the well and stabilization of water quality indicator parameters prior to sampling. While this method can be used in wells screened in any formation, it is generally used to sample low-permeability formations (i.e., low-yielding wells).

Newly constructed and developed wells shall be allowed a minimum of 48 to72 hours to stabilize before sampling is performed. Once a well is purged, it should be sampled within 2 hours. If a purged well is

allowed to sit longer than the prescribed 2 hours the water contained in the well casing may no longer be representative of aquifer conditions and the well shall be re-purged with one exception. If a water table well is purged dry, it should be sampled when a sufficient volume of water is present. In general, the sample collection shall take place within 24 hours of bailing or pumping the well dry. Purging a water table well dry should be avoided if possible. Wells screened below the water table should never be purged dry. Purging wells screened across water table must be performed at a rate that prevents significant reduction in the water table elevation. Wells that are purged dry should be sampled at least 2 hours after purging activities. Sampling of wells that are known to contain NAPL will follow procedures in SOP SAS-08-07.

5.0 EXECUTION

To the extent practical, sampling shall begin at the monitoring well with the least contamination and proceed systematically to the monitoring wells with the most contamination using the procedure outlined in the following subsections unless otherwise required by the Site-Specific Work and/or FSPs.

5.1 Preparation

The sampler shall create a work area around the monitoring well to minimize the potential for cross-contamination. Work area preparations may include the placement of polyethylene sheeting prevent sampling equipment from coming in contact with the ground surface. The sampler shall barricade and/or flag the work area, if required by the Site-Specific HASP. The sampler shall also arrange the sampling equipment and supplies to facilitate efficient execution of groundwater sampling procedures.

5.2 Well Gauging

Groundwater and non-aqueous phase liquid (NAPL), if present, elevation measurements shall be obtained in accordance with SOP SAS-08-01 or as otherwise specified in the Site-Specific Work and/or FSP. The sampler shall also obtain the total well depth from top of casing (in feet to the nearest 0.01-foot) using a water level indicator, interface probe, or steel tape, as required by the Site-Specific Work and/or FSP or otherwise specified. Total well depths may be obtained prior to the sampling and provided to the sampler. If total well depth is required to be measured immediately prior to sampling, the sampler will take precautions to minimize the displacement of sediments, if present, within the well during gauging activities. In general, the use of an interface probe shall be limited to wells containing NAPL or elevated concentrations of constituents

of concern. Groundwater and NAPL elevation measurements and total well depth measurements shall be recorded in the field logbook and/or on the appropriate field form.

5.3 Standing Water Column Calculation

The sampler shall calculate the standing water column using the following formula:

Standing Water Column $_{(Feet)}$ = TD $_{(FT\ BTOC)}$ − DTW $_{(FT\ BTOC)}$

Where: TD = Total Well Depth
FT BTOC = Feet below top of well casing
DTW = Depth to Water

The sampler shall record the calculation in the field logbook and/or on the appropriate field form.

5.4 Volume Calculations

The sampler shall calculate the volume of water required to be purged prior to sampling. Depending on data quality objectives, state- or regulatory program-specific requirements, and the Site-Specific Work and/or FSP, one of two methods may be used: casing volume or borehole volume. In general, a minimum of three volumes of water, casing or borehole, shall be purged prior to sample collection (see section 5.6 below) in addition to stabilization of groundwater quality indicator parameters.

5.4.1 Casing Volume Calculation:

The sampler shall calculate the casing volume, which is the volume of water inside the well casing only, using the following formula.

One Casing Volume $_{(Gallons)}$ = Standing Water Column $_{(Feet)}$ X Volume per One Foot of Casing ^{WDS} $_{(Gallons/Foot)}$

Where: ^{WDS} = Well diameter-specific (see table below)

Well Diameter-Specific Volume Per One Foot of Casing				
Well Diameter (Inches)	**Volume Per Foot of Casing (Gallons)**		**Well Diameter (Inches)**	**Volume Per Foot of Casing (Gallons)**
0.25	0.0026		4.0	0.6528
0.50	0.0102		6.0	1.469

Well Diameter-Specific Volume Per One Foot of Casing			
0.75	0.0230	8.0	2.611
1.0	0.0408	10.0	4.081
2.0	0.1632	12.0	5.876

The sampler shall record the calculation in the field logbook and/or on the appropriate field form.

5.4.2 Borehole Volume Calculation

The sampler shall calculate the borehole volume, which is the volume of water inside the well casing and volume of water inside the filter pack, using the following formula. Please note that this calculation requires the sampler to know the borehole diameter, filter pack height/elevation, and filter pack porosity.

One Borehole Volume $_{(Gallons)}$ = n ((A X B) – (A X C)) + (C X D)

Where: n = porosity of the filter pack (generally assumed to be 25% or 0.25)

A = height (in feet) of saturated filter pack

B = borehole diameter-specific volume (see table below)

C = well diameter-specific volume (see table below)

D = standing water column (see Section 5.4.1 above)

Diameter-Specific Volume Per One Foot of Borehole or Casing			
Diameter (Inches)	**Volume Per Foot of Borehole or Casing (Gallons)**	**Diameter (Inches)**	**Volume Per Foot of Borehole or Casing (Gallons)**
0.25	0.0026	4.0	0.6528
0.50	0.0102	6.0	1.469
0.75	0.0230	8.0	2.611
1.0	0.0408	10.0	4.081
2.0	0.1632	12.0	5.876

The sampler shall record the calculation in the field logbook and/or on the appropriate field form.

5.5 Equipment Assembly and Preparation

5.5.1 Pumps

Extreme caution should be exercised to ensure that the equipment does not cause cross-contamination from one well to the next. Therefore, dedicated tubing and pumps are preferred. Peristaltic pumps may be used when the well depth is less than or equal to fifteen feet, in zones of high contamination, or as approved in a SSWP. If it is not practical to dedicate a pump to a specific well, the pump shall be decontaminated in accordance with SOP ENV-04-04. Tubing should always be dedicated and never used for more than one well.

The sampler shall place or position the pump/tubing intake not greater than 6 feet below the dynamic water level in the well and a minimum of one foot above the well sump to the extent practical. Ideally, in non-water table wells, the pump shall be placed within the well screen section. The sampler shall slowly raise or lower the pump or tubing when placing or positioning intake in order to minimize the displacement of sediments, if present, within the well. The pump model/type, tubing (type, inner diameter, and length), and pump/tubing intake depth/elevation shall be recorded in the field logbook and/or on the appropriate field form.

5.5.2 Bailers

Bailers will be used for sampling activities when site-specific work plans provide rational and justification for the use. If a non-dedicated PVC and/or stainless steel bailer(s) is/are used, the bailer(s) must be decontaminated in accordance with SOP ENV-04-04 prior to well purging. The bailer shall be secured using rope to a purge water storage container, protective cover, flush-mount lid, or other object such that the bailer can be retrieved from the well. The rope that will enter the well casing shall not come in with the ground. Bailer samples will be collected using bottom valve sampling devices to limit sample aeration.

5.6 Purging and Groundwater Quality/Indicator Parameter Monitoring

The Site-Specific Work and/or FSP shall specify the groundwater quality/indicator parameters to be monitored, which typically include temperature, pH, specific conductance or actual conductivity, oxidation-reduction potential, dissolved oxygen, and turbidity. Parameter monitoring will begin after a minimum of one volume, casing or borehole (as specified by the Site-Specific Work and/or FSP) has been purged from the well. The sampler shall monitor and record in the field logbook and/or on the appropriate field form

parameters a minimum of every well volume until parameters have stabilized. A generic Groundwater Sampling Field Form is provided in Appendix B. When pumps are utilized for purging, stabilization parameters will be monitored with a flow through cell in accordance with SOP SAS-08-02. Parameter stabilization is considered to be achieved when three consecutive readings, taken every well volume with bailer purging, are within the parameter-specific limit listed in the table below or as specified in the Site-Specific Work and/or FSP and a minimum of three volumes, casing or borehole (as specified by the Site-Specific Work and/or FSP), have been evacuated from the well or the well is purged dry, whichever occurs first. Purging methods are discussed in Sections 5.6.1 and 5.62 below.

Parameter	**Stabilization Criteria**[1]
Conductance, Specific Electrical	+/- 3% µS/cm @ 25°C
Conductivity, Actual[2]	+/- 3% µS/cm
pH	+/- 0.1 standard units
Dissolved Oxygen	+/- 0.3 mg/L
Oxidation-Reduction Potential	+/- 10 mV
Temperature	+/- 0.1 °C
Turbidity	<10 NTUs or ± 10% when turbidity is greater than 10 NTUs and/or visually clear water

Once the parameters have stabilized and a minimum of three volumes, casing or borehole (as specified by the Site-Specific Work and/or FSP), have been evacuated from the well or the well is purged dry, sample collection shall commence (see Section 5.7 below).

5.6.1 Pumps

Following pump/tubing intake placement, the sampler shall commence with purging by turning on the pump. During pumping, intermittently collect pump discharge in a container of known volume for a period of not less than 1 minute to determine the pump flow rate. The approximate pump flow rate shall be documented in the field logbook and/or on the appropriate field form. The sampler shall monitoring groundwater quality/indicator parameters, as described in above, preferably using a flow through cell in accordance with

[1] USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA 542-S-02-001
[2] Based on the stabilization criteria for specific electrical conductance as published in the documented cited above

SOP SAS-08-03. Groundwater quality/indicator parameters shall be recorded in the field logbook and/or on the appropriate field form along with the time and volume of water purged (to the gallon). Periodic measurements of the flow rate will also be recorded during sampling. The evacuated/purged water shall be containerized in an approved storage container as required by the Site-Specific Work and/or FSP.

5.6.2 Bailers

The sampler shall slowly lower and raise the bailer in the well in order to minimize the displacement of sediments, if present, within the well. The sampler shall monitoring groundwater quality/indicator parameters by collecting bailer discharge in a disposable plastic cup, stainless steel cup, or other manner befitting the monitoring instruments (e.g., down-hole probe). Groundwater quality/indicator parameters shall be recorded in the field logbook and/or on the appropriate field form along with the time and volume of water purged. The evacuated/purged water shall be containerized in an approved storage container as required by the Site-Specific Work and/or FSP.

5.7 Sample Collection

5.7.1 Pumps

In general, groundwater samples shall only be collected from adjusted rate peristaltic pumps or adjustable rate low-flow submersible or positive displacement pumps. Groundwater samples shall be collected directly into the laboratory provided sample containers from the tubing, before the water has passed through the flow-through cell. This shall be accomplished by using a by-pass assemble or disconnecting the flow-through cell to obtain the sample. Samples shall be collected in order of analyte stability, as summarized below, unless otherwise specified by the Site-Specific Work and/or FSP:

- Volatile organic compounds (VOCs);
- Semi-volatile organic compounds (SVOCs);
- Non-filtered, non-preserved samples (e.g. Polychlorinated biphenyls (PCBs), sulfate, etc.);
- Non-filtered, preserved samples (e.g. phenols, nitrogen, cyanide, total metals, etc.);
- Filtered (reference SAS-SOP-08-02), non-preserved samples;
- Filtered (reference SAS-SOP-08-02), preserved immediately samples (e.g. dissolved metals); and
- Miscellaneous parameters.

Immediately following collection, samples shall be placed in a cooler with double-bagged ice.

5.7.2 Bailers

In general, groundwater samples shall only be collected from disposable or stainless steel bailers, when pumps are not applicable for sample collection (e.g., low-yielding wells). Groundwater samples shall be collected directly into the laboratory provided sample containers from the bailer. Samples shall be collected in order of analyte stability, as summarized below, unless otherwise specified by the Site-Specific Work and/or FSP:

- VOCs;
- SVOCs;
- Non-filtered, non-preserved samples (e.g. PCBs, sulfate, etc.);
- Non-filtered, preserved samples (e.g. phenols, nitrogen, cyanide, total metals, etc.);
- Filtered (reference SAS-SOP-08-02), non-preserved samples;
- Filtered, (reference SAS-SOP-08-02) preserved samples (e.g. dissolved metals); and
- Miscellaneous parameters.

Immediately following collection, samples shall be placed a cooler with double-bagged ice.

5.7.3 Quality Control Samples

Quality Control (QC) samples, if required, will be collected consecutively to ensure appropriate duplicate sample collection in accordance with SOP SAS-04-03. Immediately following collection, samples shall be placed in a cooler with double-bagged ice.

5.8 Post-Sample Collection

Non-dedicated and dedicated sampling equipment, which does not remain within the well casing, shall be removed from the monitoring well. The reusable and/or dedicated equipment and instruments shall be decontaminated in accordance with SOP SAS-04-04 or as otherwise specified by the Site-Specific Work and/or FSP. Disposable equipment and supplies shall be disposed of in accordance with procedures outlined in the Site-Specific Work and/or FSP. The sampler shall secure the well casing using a slip or expandable

well cap. The flush-mount lid shall be bolted down or the protective cover lid closed and locked, as appropriate.

6.0 DOCUMENTATION

Sample information, labeling, and custody control shall be performed in accordance with requirements specified in SOP SAS-03-01 and SAS-03-02. Sampling activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP SAS-01-01 or as required by the Site-Specific Work and/or FSP. A generic Groundwater Sampling Field Form is provided in Appendix B.

7.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, D4448-01 Standard Guide for Sampling Groundwater Monitoring Wells

ASTM International, D5903-96(2001) Standard Guide for Planning and Preparing for a Groundwater Sampling Event

ASTM International, D6089-97(2003)e1 Standard Guide for Documenting a Ground-Water Sampling Event

ASTM International, D6301-03 Practice for the Collection of Samples of Filterable and Nonfilterable Matter in Water

ASTM International, D6452-99(2005) Standard Guide for Purging Methods for Wells Used for Ground-Water Quality Investigations

ASTM International, D6564-00(2005) Standard Guide for Field Filtration of Ground-Water Samples

ASTM International, D6634-01 Guide for the Selection of Purging and Sampling Devices for Ground- Water Monitoring Wells

ASTM International, D6771-02 Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia, www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Manager, Region 5 and Region 10, EPA 542-S-02-001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-08-04

AQUIFER TESTING Revision 2

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for field evaluation of aquifer hydraulic conductivity. Variations in the hydraulic conductivity within or between formations or strata can create irregularities in groundwater flow paths. Formations of high hydraulic conductivity represent areas of greater groundwater flow and, therefore, zones of potential preferred contaminant migration. Further, anisotropy within strata or formations affects the magnitude and direction of groundwater flow. Thus, information on hydraulic conductivities is necessary to evaluate preferential flow paths and groundwater velocity.

Hydrogeologic assessments should contain data on the hydraulic conductivities of the significant formations underlying the site as measured in monitoring wells. It may be beneficial to use numerical or laboratory methods to augment results of field tests. However, field methods provide the best definition of the horizontal hydraulic conductivity in most cases. Field methods differ from laboratory methods which measure vertical hydraulic conductivity, typically in Shelby tube samples.

2.0 EQUIPMENT AND MATERIALS

- Pump (and generator if required) capable of withdrawal at a constant or predetermined variable rate that can meet the designed pumpage rate and lift requirements
- Water pressure transducers and data logger (bring transducers for the pumping well and each observation well as well as extras in case of malfunction)
- A flow meter or other type of water measuring device to accurately measure and monitor the discharge from the pumping well
- Sufficient hose or pipe to convey discharge outside the recharge area of the pumping well and observation wells
- Electric water level indicator(s) capable of measurement to the hundredth of a foot
- Watch or stopwatch with second hand

- Barometer (some groundwater multiprobes include a barometer)
- Tape Measure of appropriate length based on distance to observation wells.
- Flashlights, lanterns, alarm clock, electrical tape
- Semi-log graph paper, pens, and field book

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 FIELD METHODS

Varieties of procedures are available for evaluating hydraulic conductivity in the field. ASTM D4043-96(2004) Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques should be consulted in selecting an appropriate test method. Field methods for collecting hydraulic conductivity data are described in a number of ASTM standard practices:

- D2434-68(2000) Test Method for Permeability of Granular Soils (Constant Head)
- D4044-96(2002) Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers
- D4050-96(2002) Test Method (Field Procedure) for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems
- D4104-96(2004) Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests)
- D4105-96(2002) Test Method (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Modified Theis Nonequilibrium Method

- D4106-96(2002) Test Method (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Theis Nonequilibrium Method
- D4511-00 Test Method for Hydraulic Conductivity of Essentially Saturated Peat
- D4630-96(2002) Test Method for Determining Transmissivity and Storage Coefficient of Low-Permeability Rocks by In Situ Measurements Using the Constant Head Injection Test
- D4631-95(2000) Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by In Situ Measurements Using Pressure Pulse Technique
- D5269-96(2002) Test Method for Determining Transmissivity of Nonleaky Confined Aquifers by the Theis Recovery Method
- D5270-96(2002) Test Method for Determining Transmissivity and Storage Coefficient of Bounded, Nonleaky, Confined Aquifers
- D5472-93(2005) Test Method for Determining Specific Capacity and Estimating Transmissivity at the Control Well
- D5473-93(2000) Test Method for (Analytical Procedure for) Analyzing the Effects of Partial Penetration of Control Well and Determining the Horizontal and Vertical Hydraulic Conductivity in a Nonleaky Confined Aquifer
- D5720-95(2002) Practice for Static Calibration of Electronic Transducer-Based Pressure Measurement Systems for Geotechnical Purposes
- D5785-95(2000) Test Method for (Analytical Procedure) for Determining Transmissivity of Confined Nonleaky Aquifers by Underdamped Well Response to Instantaneous Change in Head (Slug Test)
- D5786-95(2000) Practice for (Field Procedure) for Constant Drawdown Tests in Flowing Wells for Determining Hydraulic Properties of Aquifer Systems
- D5850-95(2000) Test Method for (Analytical Procedure) Determining Transmissivity, Storage Coefficient, and Anisotropy Ratio from a Network of Partially Penetrating Wells
- D5855-95(2000) Test Method for (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of a Confined Nonleaky or Leaky Aquifer by Constant Drawdown Method in a Flowing Well
- D5881-95(2005) Test Method for (Analytical Procedure) Determining Transmissivity of Confined Nonleaky Aquifers by Critically Damped Well Response to Instantaneous Change in Head (Slug)
- D5912-96(2004) Test Method for (Analytical Procedure) Determining Hydraulic Conductivity of an Unconfined Aquifer by Overdamped Well Response to Instantaneous Change in Head (Slug)

- D5920-96(2005) Test Method (Analytical Procedure) for Tests of Anisotropic Unconfined Aquifers by Neuman Method
- D6028-96(2004) Test Method (Analytical Procedure) for Determining Hydraulic Properties of a Confined Aquifer Taking into Consideration Storage of Water in Leaky Confining Beds by Modified Hantush Method
- D6029-96(2004) Test Method (Analytical Procedure) for Determining Hydraulic Properties of a Confined Aquifer and a Leaky Confining Bed with Negligible Storage by the Hantush-Jacob Method
- D6030-96(2002) Guide for Selection of Methods for Assessing Groundwater or Aquifer Sensitivity and Vulnerability
- D6034-96(2004) Test Method (Analytical Procedure) for Determining the Efficiency of a Production Well in a Confined Aquifer from a Constant Rate Pumping Test
- D6391-99(2004) Test Method for Field Measurement of Hydraulic Conductivity Limits of Porous Materials Using Two Stages of Infiltration from a Borehole

5.0 SINGLE WELL TESTS

Hydraulic conductivity can be determined in the field using a variety of test methods, each addressing specific conditions, and/or data collection objectives. These methods are commonly referred to as bail down or slug tests and are performed by adding or removing a slug (known volume of water or solid inert material) from a well and observing the recovery of the water surface to its original level. Similar results can be achieved by pressurizing the well casing, depressing the water level, and suddenly releasing the pressure to simulate removal of water from the well. One method is described by McLane, et. al. (1990) and is contained in references to the Standard Practices.

When reviewing information obtained from slug tests, several criteria should be considered. First, they are run on one well and, as such, the information is limited to the geologic area directly adjacent to the screen. Second, the vertical extent of screen will control the part of the geologic formation that the test analyzes. Portions of the geologic formation(s) above or below the screen and sand filter pack and seal intervals may also require separate hydraulic conductivity testing. Third, the methods used to collect single well test data should accurately measure parameters such as changing static water (prior to initiation, during, and following completion of the test), the amount of water removed from the well (or slug volume introduced), and the

elapsed time of recovery. The use of pressure transducers and high speed recording equipment is critical in highly permeable formations.

Observation wells with screens that intersect the water table (i.e. water table wells) will be tested only by methods involving removal of water or a slug from the well in order to minimize the potential for well screen filter pack interference. The addition of water to any monitoring well shall be avoided whenever possible, since the addition may affect water quality in sampling events. When addition of water to a well is unavoidable, the water must be of documentable quality and three times the volume added to the well must be removed immediately upon completion of the test. Addition of water to an observation well is appropriate only to piezometer installation when the dynamic water level is above the well screen and sand filter pack and seal elevations.

Full development of the well screen and filter pack adjacent to the interval under examination, in accordance with SOP SAS-05-04, should be completed following well construction to ensure the removal of fines or correct deleterious drilling effects. Determination of well integrity, SOP SAS-08-05, should be determined prior to performance of the well test.

It is important that slug tests be of sufficient duration to provide representative measures of hydraulic conductivity. Slug tests will range in length from less than a minute to several hours. The time required for a test is a function of the volume of the slug added or removed the formation hydraulic conductivity, and well construction.

Slug tests should be performed at least twice to ensure the accuracy of data collection. General procedures for a slug test are summarized below. The procedures required for a slug test may vary, depending on site-specific-conditions. Modifications to the test procedures will be contained in site-specific work plans.

5.1 Slug Test Procedures with Pressure Transducer and Data Logger

An individual Slug Test Field Form (Appendix B) should be completed for each well tested and should contain at least:

- Project ID - A number assigned to identify a specific site.
- Well ID - The location of the well in which water level measurements are being taken.
- Personnel - The personnel conducting the pumping test.
- Measurement Methods - Type of pump, type of data logger(s) used to record water levels, transducer ID number, and acquisition rate (i.e. data recorded on a log scale). The transducer psi range should be appropriate to the test (e.g. 0 to 5 or 0 to 10 psi).
- Initial Static Water Level (Test Start) - Depth to water, to the nearest 0.01 feet, in the observation well at the beginning of the slug test.
- Slug Withdrawal / Addition Start Time - The date when the test began, and start time using a 24-hour clock.
- Test End Date/Time - The date and time when water level readings were discontinued.
- Final Static Water Level (Test End) - Depth to water, to the nearest 0.01 feet, in the observation well at the end of the slug test.
- Elapsed Time (min) - Time of manual measurement record from time 0.00 (start of test) recorded in minutes and seconds.
- Notes - Appropriate observations or information that has not been recorded elsewhere, including notes on sampling, pH readings, and conductivity readings.

Prior to commencing the slug test, enter site-specific information in the data logger per manufacturer instructions. Store all logger data internally; and on laptop computer and/or portable data key. The data should be transferred to the chosen backup storage device as soon as practical after the test is completed.

Water levels should be measured as specified in the SOP SAS-08-02. Manual measurements are required as a backup to and verification of the data logger(s). It is critical that depth to water readings be measured accurately and the exact time of readings is recorded. Determine the static water level in the well; measure the depth to water periodically for several minutes to several hours, and taking the average of the readings (see SOP SAS-07-02). Record information on the Slug Test Field Form (Attachment B). Additional information should be recorded on the Daily Activity Log in SOP SAS-01-04.

5.2 Slug Test Preparation

- Lower the transducer and cable in the well below the estimated target drawdown depth, ensuring the depth of submergence is within the transducer design range.
- Tape the transducer cable to the exterior of the well casing or protective cover to hold the transducer at a constant depth
- Connect the transducer cable to the data logger.
- Check the transducer accuracy by raising and lowering the transducer and comparing the change in water level from the transducer reading to the distance the transducer is raised or lowered.
- Enter the initial water level and transducer design range into the recording device according to the manufacturer's operating instructions.
- Allow the static water level to equilibrate to within 0.1 feet of the initial water level.

5.3 Slug Test with Transducer Procedure

- Turn the data logger on and begin collecting data points.
- Smoothly lower the slug/bailer into the well and allow the water level to stabilize within 0.1 feet of the initial water level.
- Remove the slug/bailer as quickly and smoothly as practical. A smooth, rapid removal is required as slug test analysis assumes an instantaneous change in volume is created in the well when the slug is removed.
- The moment the volume is removed is time zero. Collect hand measured water level measurements (Table 1) as a data backup and to verify transducer data.
- Continue measuring and recording depth/time measurements until the water level returns to equilibrium conditions or a sufficient number of readings have been made to show a trend on a plot of water level recovery versus the logarithm of time in accordance with the chosen analysis method. Time will range from less than 1 minute to a few hours.
- Repeat the slug test once the static water level has recovered to within 95 % of the original water level.

Table 1: Time Intervals for Measuring Recovery in Slug Test Well

Elapsed Time Since Start or Stop of Test (Minutes)	OR (which ever is greater)	Percent Water Level Recovery (%)	Interval Between Measurements (Minutes)
0-2		0-30	0.1
2-5		30-50	0.5
5-10		50-60	1
10-60		60-70	5
60-120		70-80	10
120-240		80-100	30

5.4 Slug Test with Water Level Meter

This slug test method should only be used if a transducer/data recorder cannot be obtained or are malfunctioning. This method cannot be used for saturated zones with high hydraulic conductivities because stabilization of groundwater will occur rapidly. Slug test data should be recorded on the Slug Test Data form (Attachment B) in accordance with the completion instructions. Follow the same procedures for Slug Test with Transducer with increased data collection frequency.

Table 2: Time Intervals for Measuring Recovery in Slug Test Well

Elapsed Time Since Start or Stop of Test (Minutes)	Interval Between Measurements (Minutes)
0-2	0.1
2-10	0.5
10-30	1
30-60	5
60-120	10
120-240	30

The interpretation of the single well test data should be consistent with the existing geologic information (boring log data). Staff should be aware of initial rapid water level recovery during a slug test may represent drainage of the filter pack material around the well screen. This is of particular concern in wells screened in low hydraulic conductivity formations (e.g. silty clay, shale). These data points should be ignored when selecting the appropriate data points to establish a water level recovery slope.

6.0 MULTIPLE WELL TESTS

Multiple well tests, more commonly referred to as pumping tests, are performed by pumping water from one well and observing the resulting drawdown in nearby wells. Tests conducted with wells screened in the same water-bearing formation provide hydraulic conductivity data. Tests conducted with wells screened in different water-bearing zones furnish information concerning hydraulic communication between units. Multiple well tests for hydraulic conductivity are advantageous because they characterize a greater proportion of the subsurface and thus provide a greater amount of detail. Multiple well tests are subject to similar constraints to those listed above for single well tests. Some additional problems that should have been considered in conducting a multiple well test include: (1) storage of potentially contaminated water pumped from the well system, and (2) potential effects of groundwater pumping on existing waste plumes. The geologic constraints should be considered to interpret the pumping test results. Incorrect assumptions regarding geology may translate into incorrect estimations of hydraulic conductivity.

7.0 LABORATORY METHODS

Laboratory analysis of undisturbed samples (e.g. Shelby tube) provides values of vertical hydraulic conductivity. When laboratory methods are to be used, the specific ASTM Standard Practice shall be referenced in samples provided to subcontractors. ASTM methods shall be consulted to assure that test methods specified are applicable to the sample to be tested.

8.0 CONTROLLED PUMPING TESTS

The most representative method for determining aquifer characteristics is by controlled aquifer pumping tests, because these tests stress a much larger volume of the formation than slug tests and laboratory tests. Pumping tests require a higher level of effort and expense than other types of aquifer tests, and are not always justified.

As an example, slug tests may be acceptable for site characterization, whereas pumping tests may be performed to support remedial design or modeling.

Aquifer characteristics that may be obtained from pumping tests include transmissivity (T), hydraulic conductivity (K), specific yield (Sy) for unconfined aquifers, and storage coefficient (S) for confined aquifers. These parameters can be determined by graphical solutions and computerized programs, such as Aqtesolv®.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required dependent on site conditions, equipment limitations, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

8.1 Summary

If possible, continuously monitor pre-test water levels at the test site for about one week prior to performance of the pump test. This information allows for the determination of the barometric efficiency of the aquifer, as well as noting changes in head due to recharge or pumping in the area adjacent to the well. Prior to initiating the long-term pump test, a step test (Section 5.5) is performed to estimate the greatest flow rate that may be sustained by the pump well.

After the pumping well has recovered from the step test, the long-term pumping test begins. At the beginning of the test, the discharge rate is set as quickly and accurately as possible. The water levels in the pumping well and observation wells are recorded following a set schedule. The duration of the test is determined by project needs and aquifer properties; typically three days or until water levels becomes constant.

8.2 Interferences and Potential Problems

Prior to conducting a pumping test, efforts should be made to anticipate and resolve interferences and potential problems that could affect the aquifer or the test. These problems could be caused by changing atmospheric conditions, impact of local potable wells, contaminants in the aquifer, etc. Note that if it is necessary for a neighboring well to pump during the test, pumping should commence as early as feasible prior to start of the test at a constant rate and not started or stopped for the duration of the test.

8.3 Pumping Discharge

If a pumping test will be conducted in an area with contaminated groundwater, special arrangements must be made for proper handling, treatment, and disposal of the water. The preferred method is to discharge to a sanitary sewer, with prior approval.

Uncontaminated groundwater discharge generated during a pumping test should be sent to storm or sanitary sewers, abiding by all applicable regulations. If there are no sewers in the vicinity of the pumping well, the discharge may be sent to a river or pond. If the previously mentioned discharge options are not available, the groundwater may be discharged to the ground surface under either of the following conditions:

- The aquifer being tested is confined; or
- The end of the discharge hose/pipe is outside of the cone of depression created by the pumping well when testing an unconfined aquifer.

8.4 Pre-Test Procedures

The hydrostratigraphy of the aquifer should be fully characterized prior to performance of the test to identify formation thickness, whether it is confined or unconfined, whether confining layers are leaky and to identify any lateral boundaries that may influence results.

If the pumping test occurs at a site where existing production and/or monitoring wells will be used, confirm that the locations and screened intervals of the wells are within the same aquifer, and meet the requirements of the method of analysis.

If possible, continuously measure water levels in the pumping well and all observation wells for a period at least equal to the length of the test. Trends should be similar in all wells. A well with an unusual trend may indicate some local stress in the aquifer.

The magnitude of water-level fluctuations due to changes in barometric pressure will change throughout the test and should be adjusted based on the changes in the barometric pressure recorded during the test. Changes in barometric pressure will be recorded during the test in order to correct water levels for any possible

fluctuations that may occur due to changing atmospheric conditions. These barometric changes are used to "correct" water levels during the test so they are representative of the hydraulic response of the aquifer due to pumping of the test well. Ideally, water levels should be measured in a well outside of the cone of depression before, during, and after pumping to determine background changes in water levels during the test and to establish correction factors for the wells within the cone of depression.

8.5 Step Test

The step drawdown test is performed to determine the maximum pumping rate that the pumping well can sustain and the minimum pumping rate necessary to assure drawdown in the observation wells. The pumping and observation wells are equipped with transducers prior to the test. Check the transducer accuracy by raising and lowering the transducer and comparing the change in water level from the transducer reading to the distance the transducer is raised or lowered.. The test is then performed by pumping at a low rate, relative to the expected final rate of pumpage, until drawdown in the pumping well stabilizes. The rate is then increased again until drawdown in the pumping well stabilizes (step 2). A minimum of three steps will be tested; the duration of each step will be similar, and should be between 30 minutes and 2 hours.

The data are then plotted on semi-log paper or on a computer. The maximum sustainable pumping rate that yields drawdown in the closest observation wells will be used as the target-pumping rate for the long-term test. These data may also be used to determine aquifer properties and well loss in the pumping well.

8.6 Pump Test Time Intervals

Commence the long-term pumping test after the pumping well has fully recovered from the step test. Place transducers into the observation wells prior to starting the test and allow time for them to equilibrate to the water temperature within the well and to collect pre-test water level data. At the beginning of the test, the discharge rate should be set as quickly and accurately as possible. Record the pumping and observation well water levels with transducers and a data logger(s) set to record logarithmically. As backup in case of transducer malfunction, manually record water levels on field forms and/or field notebooks according to the schedules in Tables 3 and 4:

Table 3: Time Intervals for Measuring Drawdown in the Pumped Well

Elapsed Time Since Start or Stop of Test (Minutes)	Interval Between Measurements (Minutes)
0-10	0.5-1
10-15	1
15-60	5
60-300	30
300-1440	60
1440-termination	480

Table4: Time Intervals for Measuring Drawdown in an Observation Well

Elapsed Time Since Start or Stop of Test (Minutes)	Interval Between Measurements (Minutes)
0-60	2
60-120	5
120-240	10
240-360	30
360-1440	60
1440-termination	480

For wells with a transducer malfunction, water levels records should be manually recorded on field forms and/or field notebooks according to the schedule in Table 5:

Table 5: Time Intervals for Measuring Drawdown in the Observation Wells with Transducer Malfunction

Elapsed Time Since Start or Stop of Test (Minutes)	Interval Between Measurements (Minutes)
0-2	0.1
2-10	0.5
10-20	1
20-100	5
100-200	10
200-300	30
300-1440	60
1440-termination	480

8.7 Water Level Measurements

Water levels will be measured as specified in the SAS-08-02. During the early part of the test, sufficient personnel are required to initiate the pumping test data loggers and assist with manual water level measurements of the pumping well and flow rate measurements. Manual measurements are required as a backup to and verification of the data logger(s). After the first two hours, one to two people are usually sufficient to continue the test. It is not necessary that readings at the wells be taken simultaneously. It is very important that depth to water readings be measured accurately and the exact time of readings is recorded.

During a pumping test, the following data must be recorded accurately on the log book and/or the aquifer test data form.

- Project ID - A number assigned to identify a specific site.
- Well ID - The location of the well in which water level measurements are being taken.
- Distance and Direction from Pumped Well - Distance and azimuth to each observation well from the pumping well in feet.
- Personnel - The personnel conducting the pumping test.

- Pumping Start and End Date/Time - The date when the pumping began, and start time using a 24-hour clock.
- Initial Static Water Level (Test Start) - Depth to water, to the nearest 0.01 feet, in the observation well at the beginning of the pumping test.
- Test End Date/Time - The date and time when water level readings were discontinued.
- Final Static Water Level (Test End) - Depth to water, to the nearest 0.01 feet, in the observation well at the end of the pumping test.
- Target Pumping Rate
- Measurement Methods - Type of pump, type of data logger(s) used to record water levels, transducer ID number, and acquisition rate (i.e. data recorded on a log scale). The transducer psi range should be appropriate to the test (e.g. 0 to 5 or 0 to 10 psi).
- Notes - Appropriate observations or information that has not been recorded elsewhere, including notes on sampling, pH readings, and conductivity readings.
- Elapsed Time (min) - Time of manual measurement record from time 0.00 (start of test) recorded in minutes and seconds.
- Depth to Water (ft) – Manual depth to water measurement, to the nearest 0.01 feet, in the observation well at the time of the water level measurement.
- Flow Rate (gal/min) - Flow rate of pump measured from an orifice, weir, flow meter, container, or other type of water measuring device.

8.8 Pump Test Duration

The duration of the test is determined by the needs of the project and properties of the aquifer. One simple test for determining adequacy of data is when the log-time versus drawdown for the most distant observation well begins to plot as a straight line on the semi-log graph paper. There are several exceptions to this simple rule of thumb; therefore, it should be considered a minimum criterion. Different hydrogeologic conditions can produce straight-line trends on log-time versus drawdown plots. In general, longer tests produce results that are more definitive. Duration of one to three days is desirable, followed by a similar period of monitoring the recovery of the water level. Unconfined aquifers and partially penetrating wells may have shorter test durations. Knowledge of the local hydrogeology, combined with a clear understanding of the

overall project objectives is necessary in judging appropriate test duration. There is no need to continue the test once the water levels in the observation wells stabilize.

The recovery of water levels following pumping phase may be measured and recorded for a period equal to the pumping phase. The frequency of the water level measurements should be similar to the frequency of water level measurements during the pumping phase (Table 1).

9.0 POST OPERATION

The following activities are performed after completion of water level recovery measurements following a slug or pumping/recovery test:

- Decontaminate and/or dispose of equipment per SAS-04-05.
- When using an electronic data-logger, use the following procedures:
  - Stop logging sequence
  - Check file size, print data, and/or save memory to a reliable storage device (i.e. hard drive or USB drive): Backup the data as soon as possible upon completion of a test!
  - Do not clear the memory of the transducer until the data has been saved onto a hard drive
- Review field forms for completeness.
- Replace testing equipment in storage containers
- Check sampling equipment and supplies. Repair or replace all broken or damaged equipment.
- Interpret slug or pumping/recovery test field results.

10.0 CALCULATIONS

Upload the data from the test into a spreadsheet to be entered into a computerized program, such as Aqtesolv®. Use the information entered into the Data Acquisition Form to complete the computer analysis of the data. There are several accepted methods for determining aquifer properties such as transmissivity, storativity, and conductivity. The appropriate method to use is dependent on the characteristics of the aquifer being tested (confined, unconfined, leaky confining layer etc.). When reviewing slug and pump test data, the following text and/or documents may be used to determine the method most appropriate to your case:

- Analysis and Evaluation of Pumping Test Data (Kruseman and Ridder, 1989)
- Applied Hydrogeology (Fetter, 2000)

- Groundwater and Wells (Driscoll, 1986)
- ASTM D4105-96(2002)
- ASTM D4106-96(2002)

11.0 QUALITY ASSURANCE/ QUALITY CONTROL (QA/QC)

Gauges, transducers, flow meters, and other equipment used in the pumping tests will be calibrated before use at the site. Copies of the documentation of instrumentation calibration will be filed with the test data records. The calibration records will consist of laboratory measurements and, if necessary, any on-site zero adjustment and/or calibration that were performed. Where possible, all flow and measurement meters will be checked on-site using a container of measured volume and stopwatch; the accuracy of the meters must be verified before testing proceeds. For QA/QC purposes, a minimum of two single well tests (slug test) should be performed in each well that hydraulic conductivity testing is performed.

12.0 DATA REDUCTION AND INTERPRETATION

Slug and multiple well test data can be analyzed by a variety of methods, depending on the responses observed, geologic conditions, and specific well parameters. Texts such as Driscoll (1986) or other well hydraulics references should be consulted for selection of the proper method of data analysis. In reviewing hydraulic conductivity measurements, the following criteria should be considered to evaluate the accuracy or completeness of information.

- Values of hydraulic conductivity between wells in similar lithologies should generally not exceed one order of magnitude difference.
- Hydraulic conductivity determinations based upon multiple well tests are preferred. Multiple well tests provide more complete information because they characterize a greater portion of the subsurface.
- Use of single well tests will require that more individual tests be conducted at different locations to sufficiently define hydraulic conductivity variation across the site.
- Hydraulic conductivity information generally provides average values for the entire area across a well screen. For more depth discrete information, well screens will have to be shorter. If the average hydraulic conductivity for a formation is required, entire formations may have to be screened, or data taken from overlapping clusters.

It is important that measurements define hydraulic conductivity both vertically and horizontally across the site. Laboratory tests may be necessary to ascertain vertical hydraulic conductivity in saturated formations or strata. Results from boring logs should also be used to characterize the site geology. Zones of high permeability or fractures identified from drilling logs should be considered in the determination of hydraulic conductivity. Additionally, information from boring logs can be used to refine the data generated by single well or pumping tests.

13.0 REFERENCES AND ADDITIONAL RESOURCES

Bouwer, H., and Rice, R.C., "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with completely or Partially Penetrating Wells", Water Res. Res., 12 p. 423-428, 1976.

Driscoll, F. G., 1986, Groundwater and Wells, Johnson Division, St. Paul, MN, 1089 p.

McLane, G. A., D. A. Harrity, K. O. Thomsen, "Slug Testing In Highly Permeable Aquifers Using a Pneumatic Method", Hazardous Materials Control Research Institute, Conference Proceedings, November, 1990, pp 300-303.

ASTM International, D2434-68(2000) Test Method for Permeability of Granular Soils (Constant Head)

ASTM International, D4043-96(2004) Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques

ASTM International, D4044-96(2002) Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers

ASTM International, D4050-96(2002) Test Method (Field Procedure) for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems

ASTM International, D4104-96(2004) Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests)

ASTM International, D4105-96(2002) Test Method (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Modified Theis Nonequilibrium Method

ASTM International, D4106-96(2002) Test Method (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Theis Nonequilibrium Method

ASTM International, D4511-00 Test Method for Hydraulic Conductivity of Essentially Saturated Peat

ASTM International, D4630-96(2002) Test Method for Determining Transmissivity and Storage Coefficient of Low-Permeability Rocks by In Situ Measurements Using the Constant Head Injection Test

ASTM International, D4631-95(2000) Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by In Situ Measurements Using Pressure Pulse Technique

ASTM International, D5269-96(2002) Test Method for Determining Transmissivity of Nonleaky Confined Aquifers by the Theis Recovery Method

ASTM International, D5270-96(2002) Test Method for Determining Transmissivity and Storage Coefficient of Bounded, Nonleaky, Confined Aquifers

ASTM International, D5472-93(2005) Test Method for Determining Specific Capacity and Estimating Transmissivity at the Control Well

ASTM International, D5473-93(2000) Test Method for (Analytical Procedure for) Analyzing the Effects of Partial Penetration of Control Well and Determining the Horizontal and Vertical Hydraulic Conductivity in a Nonleaky Confined Aquifer

ASTM International, D5720-95(2002) Practice for Static Calibration of Electronic Transducer-Based Pressure Measurement Systems for Geotechnical Purposes

ASTM International, D5785-95(2000) Test Method for (Analytical Procedure) for Determining Transmissivity of Confined Nonleaky Aquifers by Underdamped Well Response to Instantaneous Change in Head (Slug Test)

ASTM International, D5786-95(2000) Practice for (Field Procedure) for Constant Drawdown Tests in Flowing Wells for Determining Hydraulic Properties of Aquifer Systems

ASTM International, D5850-95(2000) Test Method for (Analytical Procedure) Determining Transmissivity, Storage Coefficient, and Anisotropy Ratio from a Network of Partially Penetrating Wells

ASTM International, D5855-95(2000) Test Method for (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of a Confined Nonleaky or Leaky Aquifer by Constant Drawdown Method in a Flowing Well

ASTM International, D5881-95(2005) Test Method for (Analytical Procedure) Determining Transmissivity of Confined Nonleaky Aquifers by Critically Damped Well Response to Instantaneous Change in Head (Slug)

ASTM International, D5912-96(2004) Test Method for (Analytical Procedure) Determining Hydraulic Conductivity of an Unconfined Aquifer by Overdamped Well Response to Instantaneous Change in Head (Slug)

ASTM International, D5920-96(2005) Test Method (Analytical Procedure) for Tests of Anisotropic Unconfined Aquifers by Neuman Method

ASTM International, D6028-96(2004) Test Method (Analytical Procedure) for Determining Hydraulic Properties of a Confined Aquifer Taking into Consideration Storage of Water in Leaky Confining Beds by Modified Hantush Method

ASTM International, D6029-96(2004) Test Method (Analytical Procedure) for Determining Hydraulic Properties of a Confined Aquifer and a Leaky Confining Bed with Negligible Storage by the Hantush-Jacob Method

ASTM International, D6030-96(2002) Guide for Selection of Methods for Assessing Groundwater or Aquifer Sensitivity and Vulnerability

ASTM International, D6034-96(2004) Test Method (Analytical Procedure) for Determining the Efficiency of a Production Well in a Confined Aquifer from a Constant Rate Pumping Test

ASTM International, D6391-99(2004) Test Method for Field Measurement of Hydraulic Conductivity Limits of Porous Materials Using Two Stages of Infiltration from a Borehole

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-08-05

WELL INTEGRITY INSPECTION, MAINTENANCE, AND REHABILITATION Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for inspecting groundwater monitoring well integrity. The well integrity inspection identifies wells that in their current condition are not suitable for obtaining groundwater/product elevations, water quality and/or hydraulic information, groundwater/product samples and/or other data obtained using the well. The results of the evaluation shall be used to ensure the integrity of wells over extended periods of time by identifying conditions that warrant well maintenance and/or rehabilitation. This SOP also describes well maintenance and rehabilitation.

2.0 EQUIPMENT AND MATERIALS

- Map of well locations;
- Tools and well keys, as required to facilitate access to wells;
- Water level measuring device (electronic water level indicator, interface probe, or weighted steel tape);
- Adjustable rate pump, adjustable rate submersible or positive displacement bladder pump (Note: The Site-Specific Work and/or Field Sampling Plan (FSP) shall specify the type of pump required);
- 1/4 to 3/8-inch Teflon®, polyvinyl chloride (PVC), or polypropylene tubing, if applicable;
- Power source, if applicable;
- Compressed inert gas source (for use with bladder pump), if applicable;
- PVC or stainless steel bailer or solid slug;
- Rope;
- Pressure transducer and automatic data logger, if applicable;
- Container(s) for purge water storage (e.g. 5-gallon buckets, polyethylene storage tank, etc.);
- Existing well boring/construction logs, if available;
- Groundwater elevation table, if available;
- Polyethylene sheeting, as appropriate;

- Camera;
- Personal protection equipment; and
- Field logbook and/or appropriate field forms.

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

Inspections shall be performed at the frequencies described below or as required by the Site-Specific Work Plan to 1) verify the structural integrity of the wells above and below ground, 2) identify significant silt/sediment buildup in wells, and 3) identify biofouling that could contribute to corrosion of structures or decrease in the efficiency of recovery and pumping operations.

4.1 Well Location Verification

The location of each well shall be compared to that given on the site map. If the well location is found to be in error, the well shall be resurveyed and/or re-delineated relative to site features and its position adjusted on the map.

4.2 Aboveground Structural Integrity Inspection

The physical condition of the well will be determined by visually inspecting aboveground components during each monitoring and/or sampling event. Components to be inspected include:

- Protective casing/flush-mount cover;
- Bumper posts, if applicable;
- Concrete pad or apron, if applicable;
- Well cap (expandable or slip);
- Locking mechanism;
- Exposed top of casing; and
- Surface drainage around the wells.

If the aboveground components are damaged, well maintenance or rehabilitation is required (see Section 4.3).

4.3 Below Ground Well Structural Integrity Inspection

4.3.1 General

Total depth measurements shall be obtained annually in accordance with SOP ENV-08-01 and compared to the baseline total depth measurements obtained at the time of well installation, development, and/or start of the project. If a significant amount of silt/sediment is present, well maintenance or rehabilitation is required (see Section 4.4). Additionally, single well aquifer testing may be performed to determine if silt/sediment has decreased the well hydraulic conductivity, indicating well maintenance or rehabilitation is necessary for collection of representative data. Use of this test will be determined on a site-specific basis or as otherwise determine in the SSWPs.

4.3.2 Monitoring Wells

A stainless steel or PVC bailer or slug, with a diameter and length equivalent to a sampling pump or bailer, shall be lowered the entire length of the well to identify obstructions or damage to the well casing and screen. If the bailer or slug cannot be lowered to within the screened interval, an obstruction or damage exists that requires well maintenance or rehabilitation (see Section 4.4). If well yield decreases significantly, well

integrity may be assessed using a single well aquifer test to determine if well maintenance or rehabilitation is required.

4.3.3 Vapor Extraction Wells

Vacuum and air flow rates shall be measured periodically in accordance with system-specific procedures and compared to previous steady-state measurements and the current operational status of the system. If a significant change in vacuum and/or air flow rates is observed and not substantiated by the current operational status of the system, well maintenance or rehabilitation is required (see Section 4.4).

4.3.4 Recovery Wells

Recovery rates shall be evaluated at least once every quarter and compared to previous measurements. If a significant change in rates is observed and not substantiated by current product/water levels, well maintenance or rehabilitation is required (see Section 4.4).

4.4 Well Maintenance or Rehabilitation

Deficiencies or damage identified during aboveground and below ground well integrity inspections shall be evaluated on a case-by-case basis. Well maintenance or rehabilitation that cannot be implemented at the time of inspection shall be implemented within a reasonable period of time. Well maintenance or rehabilitation may include, but is not limited to, the following:

- Replacement of aboveground components;
- Silt/sediment removal;
- Well surging and redevelopment;
- Biomass removal and/or cleaning with an approved biocide; and
- Equipment (e.g. pumps, etc.) repair or replacement.

If deficiency or damage cannot be corrected through well maintenance or rehabilitation, the well shall be abandoned in accordance with SOP ENV-05-05 and applicable federal, state, and local regulations. Wells critical to site activities and/or operations shall be replaced in accordance with SOPs ENV-05-03 and ENV-05-04, applicable federal, state, and local regulations, and the Site-Specific Work Plan.

4.5 Decontamination

Non-Dedicated and dedicated equipment used for inspection and/or corrective action activities, which does not remain within the well casing, shall be removed from the well. The reusable and/or dedicated equipment and instruments shall be decontaminated in accordance with SOP ENV-04-04 or as otherwise specified by the Site-Specific Work Plan. Disposable equipment and supplies shall be disposed of in accordance with procedures outlined in the Site-Specific Work Plan.

5.0 DOCUMENTATION

Inspection, maintenance, and rehabilitation activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP ENV-01-01 or as otherwise required by the Site-Specific Work Plan.

6.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, D6089-97(2003) Standard Guide for Documenting a Ground-Water Sampling Event

ASTM International, D4448-01 Standard Guide for Sampling Groundwater Monitoring Wells

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia, www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-08-06

POTABLE WATER WELL SAMPLING Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the collection of water samples from water supply wells. Potable water samples are collected to evaluate the potable water supply. In some cases, potable water samples may be collected to evaluate the delivery system (e.g. well casing, pump, piping, etc.). The sampling guidelines described in the SOP are intended to facilitate the collection of representative samples.

2.0 EQUIPMENT AND MATERIALS

- Hand tools (e.g. crescent wrenches, pipe wrenches, and slip joint pliers), as needed;
- Garden water hose;
- Plastic sheeting;
- Graduated cylinder;
- Stopwatch;
- Sample containers and labels;
- Cooler with ice;
- Chain of custody forms and seals; and
- Personal protective equipment.

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read

and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 PREPARATIONS

4.1 Sample Location Selection

In general, the installation of a sampling tap to obtain samples shall not be warranted. Potable water samples shall be collected from taps or spigots on the existing delivery system. Prior to sampling, the tap closest to the well shall be identified for sample collection. This location, to the extent practical, should be upstream of any filtration or water treatment device(s). If the location is not upstream of any filtration or water treatment device, the sampler shall recorded the type, manufacturer, and model of each filtration or water treatment device in the field logbook and/or on the appropriate field form. On rare occasions a tap or spigot may not be available for sampling. In these instances, the closest access point to the wellhead shall be selected for sampling. When project objectives include an evaluation of the water delivery, a representative location downstream of filtration or water treatment devices, may be selected. The selected or preferred sample locations shall be described in the Site-Specific Work and/or Field Sampling Plan (FSP).

4.2 Groundwater Elevation and Well Depth Measurements

In general, it is preferred to not obtain groundwater elevations and well depth measurements from public or private water supply wells. In most cases, groundwater elevation and well depth shall be estimated based on the driller's log and/or well completion report. In rare instances it may be necessary to measure groundwater elevation. In these cases, measurements shall be obtained using an electronic water level indicator or an un-weighted steel tape with the loop removed, which has been dedicated for use in potable water wells only and has been properly decontaminated and stored to prevent the introduction of contamination into the well. In addition, the water level indicator shall not be lowered any deeper than is necessary to obtain the groundwater elevation measurement. The need to use chlorine pellets to sanitize the well after measurements are collected will be evaluated on a site-specific basis, as described in SSWPs.

4.3 Calculation of the Pre-Sample Purge Volume

When potable water samples are being collected to evaluate the potable water source, all standing/stagnant water shall be purged from the delivery system immediately prior to sample collection. The volume of water contained in the well casing, pressure or holding tanks, and other plumbing and appurtenances (pipes, hoses, etc.) shall be estimated by the sampler. All estimated volumes of water contained in plumbing and appurtenances, assumptions, and calculations shall be recorded in the field logbook and/or on the appropriate field form.

5.0 EXCUTION

5.1 Pre-Sample Purging

If sample(s) are being collected to evaluate the delivery system, a first draw sample shall be collected prior to the purging (see Section 5.3 below). If samples are being collected to evaluate the potable water supply, the system shall then be purged with a minimum of three times the calculated purge volume before sampling commences. If no information regarding well depth is available, purging shall be performed a minimum of 15 minutes after the well pump engages prior to sampling in addition to the time required to evacuate pre-sample port systems (e.g. pressure tank, water softener, etc.). Pre-sample purging shall also take into account the following, if known:

- Pump intake level;
- Specific capacity of the aquifer; and
- Well efficiency.

Purged water if discharged to the ground surface shall be done in a manner that prevents icy conditions or damage on the property. In addition, the sampler shall divert purge water away from the wellhead or building using hoses, plastic sheeting, irrigation pipe, or other appropriate means, to the extent practical. Purge waters shall be disposed at the nearest sump or drain available whenever possible.

If samples are being collected to evaluate the delivery system, the initial/first draw sample shall be collected prior to purging activities.

5.2 Groundwater Quality/Indicator Parameter Monitoring

The Site-Specific Work and/or Sampling Plan(s) shall specify the groundwater quality/indicator parameters to be monitored, which typically include temperature, pH, specific conductance or actual conductivity, oxidation-reduction potential, dissolved oxygen, and turbidity. Parameter monitoring will begin at the start of purging from the delivery system. The sampler shall monitor and record in the field logbook and/or on the appropriate field form parameters every five to ten minutes (during continuous purging) until parameters have stabilized. Parameter stabilization is considered to be achieved when three consecutive readings, taken within 2 to 3 minute intervals are within the parameter-specific limit listed in the table below or as specified in the Site-Specific Work and/or Sampling Plan(s).

Parameter	**Stabilization Criteria[1]**
Conductance, Specific Electrical	+/- 3% µS/cm @ 25°C
Conductivity, Actual[2]	+/- 3% µS/cm
Dissolved Oxygen	+/- 0.3 mg/L
Oxidation-Reduction Potential	+/- 10 mV
pH	+/- 0.1 standard units
Temperature	+/- 0.1 °C
Turbidity	+/- 10% NTUs or three consecutive readings less than or equal to 10 NTUs

Once the parameters have stabilized, purging is considered complete and sample collection shall commence, with the exception of the collection of a first draw sample. The first draw sample shall be collected prior to delivery system purging.

[1] USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA 542-S-02-001
[2] Based on the stabilization criteria for specific electrical conductance as published in the documented cited above

5.3 SAMPLING PROCEDURES

The sampler shall collect the potable water sample(s) from a tap or spigot on the existing delivery system, which is closest to the well. This location, to the extent practical, should be upstream of any filtration or water treatment device(s). If the location is not upstream of any filtration or water treatment device, the sampler shall recorded the type, manufacturer, and model of each filtration or water treatment device in the field logbook and/or on the appropriate field form. The location, including a sketch, shall also be documented in the field logbook and/or on the appropriate field form.

Following purging activities, the sampling tap shall be shut off. The tap shall be turned on and adjusted to an approximate flow of 100 ml/min using a graduated cylinder and a stopwatch. The flow rate shall be recorded in the field logbook and/or on the appropriate field form. Sample bottles shall be filled in a manner which minimizes aeration. The sample bottles shall be filled as required in order of decreasing volatility. Any pertinent field observations (e.g. odors, discoloration, etc.) shall also be recorded in the field logbook and/or on the appropriate field form.

6.0 POST-SAMPLING PROCEDURES

Following sample collection, any filters, aerators, and/or treatment systems disconnected prior to sampling activities shall be reconnected. In addition, the sampling site shall be cleaned before leaving the vicinity.

7.0 DECONTAMINATION

Following sample collection, all equipment shall be decontamination as described in SOP ENV-04-04 or as otherwise specified by the Site-Specific Work and/or Sampling Plan(s).

8.0 DOCUMENTATION

Sample information, labeling, and custody control shall be performed in accordance with requirements specified in SOP ENV-03-01 and ENV-03-02. Sampling activities, including pertinent field information and observations, shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP ENV-01-01 or as required by the Site-Specific Work and/or FSP including, but not limited to, the following:

- Condition of the well and dedicated equipment;
- Owner’s and occupant’s name(s);

- Facility name and address;
- Sampling location (specific tap or spigot);
- Filtering or treatment systems on delivery systems (if applicable);
- Aerator or filter on sampling tap;
- Pressure on holding tank volume (if applicable);
- Purge flow rate;
- Purge time;
- Total purge volume;
- Sample appearance (odor, color, turbidity, etc.); and
- Calculations for purge volumes.

9.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 1994, D5612-94R03 Guide for Quality Planning and Field Implementation of a Water Quality Measurement Program

ASTM International, 1995, D5851-95R00 Guide for Planning and Implementing a Water Monitoring Program

ASTM International, 2001, D5903-96(2001) Standard Guide for Planning and Preparing for a Groundwater Sampling Event

USEPA, 2001, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), Region 4, Enforcement and Investigations Branch, SESD, Athens, Georgia.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-08-07

NON-AQUEOUS PHASE LIQUID SAMPLING Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the collection of non-aqueous phase liquid (NAPL) samples from monitoring, observation, and/or recovery wells. NAPL samples are collected to support plume characterization and/or treatment/recovery system design. Light and dense NAPL, also referred to as LNAPL and DNAPL, may be collected for physical parameter determination (e.g. density, viscosity, etc.), simulated distillation, fingerprinting, waste characterization, etc.

2.0 EQUIPMENT AND MATERIALS

Equipment and materials may vary based on the type of NAPL being sampled (light or dense). In general, the following equipment and materials shall be required unless otherwise specified by the Site-Specific Work and/or Field Sampling Plan (FSP):

LNAPL Sample Collection:

- Bailer (disposable or dedicated);
- Rope;
- Peristaltic pump;
- Polyvinyl chloride or Teflon tubing (disposable or dedicated), as appropriate; and
- Silicone tubing (disposable or dedicated).

DNAPL Sample Collection:

- Solinst Model 425 Discrete Interval Sampler or equivalent;
- Low density polyethylene (LDPE) tubing;
- Solinst Reel or equivalent;
- High pressure hand pump or compressed air source with regulator; and
- Rope.

General:

- Water and NAPL gauging equipment (see SOP ENV-08-01);
- 5-gallon bucket;
- Approved storage container(s) (55-gallon drum, polyethylene tank, etc.);
- Sample containers and labels;
- Chain of custody forms and seals;
- Decontamination materials/equipment;
- Personal protective equipment; and
- Field logbook and/or appropriate field form.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

4.1 Preparation

The sampler shall create a work area around the monitoring well to minimize the potential for cross-contamination. Work area preparations may include the placement of polyethylene sheeting prevent sampling equipment from coming in contact with the ground surface. The sampler shall barricade and/or flag the work area, if required by the Site-Specific HASP. The sampler shall also arrange the sampling equipment and supplies to facilitate efficient execution of NAPL sampling procedures.

4.2 Well Gauging

Groundwater and NAPL elevation measurements shall be obtained in accordance with SOP ENV-08-01 or as otherwise specified in the Site-Specific Work and/or FSP. Following sampling activities, the sampler shall also obtain the total well depth from top of casing (in feet to the nearest 0.01-foot) using a water level indicator, interface probe, or steel tape, as required by the Site-Specific Work and/or FSP or otherwise specified. Total well depths may be obtained prior to the sampling (at least one to two weeks in advance) and provided to the sampler. Groundwater and NAPL elevation measurements and total well depth measurements shall be recorded in the field logbook and/or on the appropriate field form.

4.3 Standing NAPL Column and Casing Volume Calculations

The sampler shall calculate the standing NAPL column and casing volume using the following formulas:

4.3.1 LNAPL Column

Standing LNAPL Column $_{(Feet)}$ = DTW $_{(FT\ BTOC)}$ – $DTP_{L\ (FT\ BTOC)}$

Where: DTW = Depth to Water
FT BTOC = Feet below top of well casing
DTP_L = Depth to Product (LNAPL)

4.3.2 DNAPL Column

Standing DNAPL Column $_{(Feet)}$ = TD $_{(FT\ BTOC)}$ – $DTP_{D\ (FT\ BTOC)}$

Where: TD = Total Well Depth
FT BTOC = Feet below top of well casing
DTP_D = Depth to Product (DNAPL)

4.3.3 Casing Volume

Casing Volume $_{(Gallons)}$ = Standing NAPL Column $_{(Feet)}$ X Volume per One Foot of Casing ^{WDS} $_{(Gallons/Foot)}$

Where: ^{WDS} = Well diameter-specific (see table below)

Well Diameter-Specific Volume Per One Foot of Casing			
Well Diameter (Inches)	Volume Per Foot of Casing (Gallons)	Well Diameter (Inches)	Volume Per Foot of Casing (Gallons)
0.25	0.0026	4.0	0.6528
0.50	0.0102	6.0	1.469
0.75	0.0230	8.0	2.611
1.0	0.0408	10.0	4.081
2.0	0.1632	12.0	5.876

The sampler shall recorded calculations in the field logbook and/or on the appropriate field form.

4.4 Bailer/Tubing/Sampler Intake Position Determination

The sampler should determine the position/depth of the bailer/tubing/sampler intake, using the water and NAPL elevation measurements, such that the intake will be positioned within the bottom quarter of the NAPL column. The intake position (depth/elevation) shall be recorded in the field logbook and/or on the appropriate field form. In addition, the sampling equipment shall also be recorded in the field logbook and/or on the appropriate field form.

4.5 Well Evacuation

In order to obtain a representative NAPL sample from an existing well, the product that has stagnated and/or may have chemically changed in the well casing shall be removed prior to sampling. The evacuation will allow fresh NAPL to enter the well from the formation.

4.5.1 LNAPL Evacuation

If using a bailer, the sampler shall slowly lower the bailer to the intake position. The bailer shall be slowly retrieved from the well and the contents emptied into a 5-gallon bucket or an approved storage container. This process shall continue until no measurable amount (< 0.01 foot) of LNAPL remains or one casing volume of LNAPL has been removed, whichever occurs first. If using a peristaltic pump, the sampler shall

slowly lower the tubing to the intake position. The pump shall be turned on and the removed LNAPL shall be collected in a 5-gallon bucket or an approved storage container. The pump process shall continue until no measurable amount (< 0.01 foot) of LNAPL remains or one casing volume of LNAPL has been removed, whichever occurs first.

The volume of LNAPL evacuated from the well shall be recorded in the field logbook and/or on the appropriate field form.

4.5.2 DNAPL Evacuation

The discrete interval sampler shall be connected to the tubing and reel. The high pressure hand pump or compressed air shall be connected to the reel. The sampler shall be pressured to the recommended operating pressure for the intake position/depth according to the following unless otherwise specified by the sampler operations manual and/or Site-Specific Work and/or FSP.

Recommended Operating Pressure[1]			
Depth		**Pressure**	
Feet	**Meters**	**psi**	**kPa**
25	8	20	148
50	15	30	217
100	30	50	364
200	61	95	670
300	90	140	952
500	150	225	1,495

Notes: 1. Operating pressure = (Sample depth in feet X 0.43) + 10 psi

2. Operating pressure = (Sample depth in meters X 9.8) + 70 kPa

3. psi = pounds per square inch

4. kPa = kiloPascals

[1] http://www.groundwatersoftware.com/Equipment/solinst_model_425.htm

While pressurized, the sampler shall then be lowered to the intake position/depth. At the desire depth, the pressure shall be released, which will allow the sampler to fill by hydrostatic pressure. The sampler shall then be re-pressurized to the recommended operating pressure. Following, re-pressurization, the sampler shall be slowly raised to the surface. The contents shall be transferred to the 5-gallon bucket or approved storage container via the sample release device. This process shall continue until no measurable amount (< 0.01 foot) of DNAPL remains or one casing volume of DNAPL has been removed, whichever occurs first.

4.6 Post NAPL Evacuation Activities

Groundwater and NAPL elevation measurements shall be measured and monitored in accordance with SOP ENV-08-01 or as otherwise specified in the Site-Specific Work and/or FSP. Once the NAPL column has recovered to a level equivalent or greater than the prescribed sample volume, sampling may commence.

4.7 Sample Collection

4.7.1 LNAPL Sample Collection

If using a bailer, the sampler shall slowly lower the bailer to the intake position. The bailer shall be slowly retrieved from the well and the contents emptied into the appropriate sample container(s).

If using a peristaltic pump, the sampler shall slowly lower the tubing to the intake position. The pump shall be turned on and the removed LNAPL shall be emptied into the appropriate sample container(s).

4.7.2 DNAPL Sample Collection

The discrete interval sampler shall be connected to the tubing and reel. The high pressure hand pump or compressed air shall be connected to the reel. The sampler shall be pressured to the recommended operating pressure for the intake position/depth according to the following unless otherwise specified by the sampler operations manual and/or Site-Specific Work and/or FSP (see Section 4.5.2). While pressurized, the sampler shall then be lowered to the intake position/depth. At the desire depth, the pressure shall be released, which will allow the sampler to fill by hydrostatic pressure. The sampler shall then be re-pressurized to the recommended operating pressure. Following, re-pressurization, the sampler shall be slowly raised to the

surface. The contents shall be transferred to the appropriate sample container(s) via the sample release device.

4.8 Post Sample Collection

Non-Dedicated and dedicated sampling equipment, which does not remain within the well casing, shall be removed from the monitoring well. The reusable and/or dedicated equipment and instruments shall be decontaminated in accordance with SOP ENV-04-04 or as otherwise specified by the Site-Specific Work and/or FSP. Disposable equipment and supplies shall be disposed of in accordance with procedures outlined in the Site-Specific Work and/or FSP. The sampler shall secure the well casing using a slip or expandable well cap. The flush-mount lid shall be bolted down or the protective cover lid closed and locked, as appropriate.

5.0 Documentation

Sample information, labeling, and custody control shall be performed in accordance with requirements specified in SOP ENV-03-01 and ENV-03-02. Sampling activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP ENV-01-01 or as required by the Site-Specific Work and/or FSP.

6.0 REFERENCES AND ADDITIONAL RESOURCES

http://www.groundwatersoftware.com/Equipment/solinst_model_425.htm

USEPA, 2002, Ground-Water Sampling Guidelines for Superfund and RCRA Project Manager, Region 5 and Region 10, EPA 542-S-02-001.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/60/B-07/001.

SOP SERIES SAS-09

SURFACE WATER SAMPLING AND MEASUREMENT PROCEDURES

STANDARD OPERATING PROCEDURE NO. SAS-09-01

SURFACE WATER SAMPLING FOR CHEMICAL AND BIOLOGICAL ANALYSIS Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the collection of grab surface water samples for chemical and biological analysis using manual sampling techniques. The collection of composite surface water samples using automatic samplers shall be address in an equipment-specific SOP or the Site-Specific Work Plan, as needed. Surface water samples are utilized for the characterization of surface water and assessment of human and ecological receptors.

2.0 EQUIPMENT AND MATERIALS

Sampling equipment and materials vary by collection method. However, some standard equipment and materials are required regardless of collection method:

- Hip or chest waders, as appropriate;
- Boat and personal floatation devices (PFDs), as needed;
- Sample bottles/containers and labels;
- Field logbook and/or the appropriate field form(s);
- Pens with waterproof, non-erasable ink;
- Chain of custody forms;
- Depth and length measurement devices;
- Survey stakes, flags, or buoys and anchors;
- Decontamination materials;
- Coolers and ice packs/double-bagged ice;
- Personal protective equipment; and
- Camera.

3.0 HEALTH AND SAFETY WARNINGS

Aquatic environments present unique health and safety concerns ranging from accessibility to water depth and velocity to indigenous species. Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Work on water requires that marine health and safety procedures are used in addition to standard health and safety procedures. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 PERMITTING

Sampling performed within navigable waters and critical habitats may fall under the jurisdiction of one or more federal, state, or local agencies, including by not limited to the United States Army Corp of Engineers (USACOE), US Department of Fish and Wildlife, and State Departments of Natural Resources. Prior to the commencement of sampling activities, appropriate permit(s), if applicable, shall be obtained.

5.0 EXECUTION

5.1 General Considerations

The scope or extent of the sampling effort, data quality objectives, type(s) of samples (e.g. surface or depth grab), and sampling technique shall be determined prior to sample site selection and sample collection. In addition, the hydrology and morphometrics of a stream or impoundment shall be determined to the extent practical prior to sample collection. Water quality data (e.g. dissolved oxygen, pH, and temperature, etc.) shall be collected prior to sample collection, to the extent practical, to determine if stratification is present. These sampling activities should be restricted to seasons when ice is not present, unless specified by a Site-Specific Work Plan and/or Field Sampling Plan (FSP). The Site-Specific Work Plan and/or FSP, as appropriate, shall specify the type(s) of samples to be collected and the collection technique(s).

5.2 Sample Site Selection

An initial reconnaissance shall be performed, to the extent practical, identify suitable sampling locations. Bridges and piers shall generally be deemed acceptable sampling locations since they provide ready access and permit water sampling at any point across the width of the water body. However, data quality objectives (DQOs) must be reviewed prior to final acceptance of these structures as sampling locations, since these structures alter the nature of water flow. When samples will be collected by wading in lakes, ponds, and slow-moving rivers and streams, sampling locations shall be selected that allow the sampler to approach the location from downstream in order to minimize the disturbance of sediments. Sampling station locations shall be selected without regard to other means of access if the stream is navigable by boat. However, other factors including but not limited to the following shall be considered in the sample site selection process:

- Project goals and DQOs;
- Field personnel health and safety;
- Manmade structures that alter the nature of water flow and mixing;
- General water environment characteristics (e.g. flow, depth, stratification, etc.);
- Potential disturbance of threatened or endangered species or critical habitat; and
- Type of water environment: river, streams, creeks; lakes, ponds, impoundments, estuarine, etc.

5.3 Surface Grab Sample Collection Procedures

Surface grab samples shall be collected from the top 12 inches of the water column. Samples shall be collected in a manner that avoids skimming of the surface and disturbance of sediments. If sample collection is performed by wading in the stream, the location shall be approached from a downstream location and efforts shall be made to minimize sediment disturbance, which has the potential to bias the sample. Wading shall be deemed acceptable if a noticeable current is present and the samples can be collected directly into the bottle from a location upstream of the field personnel. The field personnel shall approach the sample location slowly from downstream in order to minimize sediment disruption and sample corruption.

5.3.1 Direct Grab Sampling

Where practical, use of the actual sample container as the collection device is preferred since the same container can be submitted for laboratory analysis. This procedure reduces sample handling and potential loss of analytes or contamination from the sample from other sources. The following procedure shall be used for direct grab sample collection using unpreserved sample containers:

1. Remove the container cap or lid.
2. Slowly submerge the container, opening first, into the water.
3. Invert the container so the opening is upright and pointing towards the direction of water flow (if applicable) and allow water to slowly run into and fill the container.
4. Return the filled container to the surface.
5. If field preservation is required, proceed to Step 6; otherwise, secure the container cap or lid and proceed to Step 10.
6. Pour out a small volume of sample away from and downstream of the sampling location. (Do not use this step for volatile organics or other analytes that require zero headspace.)
7. Add the appropriate volume of the analytical method-prescribed preservative and secure the container cap or lid.
8. Invert the container several times to ensure sufficient mixing of the sample and preservative.
9. Check the preservation of the sample; adjust the pH of the sample with additional preservative, if necessary; and re-secure the cap or lid.
10. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.3.2 Sampling with an Intermediate Vessel or Container

If the sample cannot be collected directly in the sample container(s), an unpreserved sample container or an intermediate vessel (e.g. beaker, bucket, or dipper with or without an extension arm) shall be used to obtain the sample using the following procedure:

1. Decontamination the intermediate vessel in accordance with SOP ENV-04-04 or use certified clean, laboratory provided, unpreserved bottles.
2. Fill the intermediate vessel or container by slowly dipping it into the water with the opening pointing towards the direction of water flow (if applicable);

3. Allow water to slowly run into and fill the intermediate vessel or container in a manner that minimizes agitation of the sample;
4. If field preservation is required, ensure the preservative is present in the sample container prior to transfering water from the intermediate vessel;
5. Remove the sample container lid and fill the sample container(s) from the intermediate vessel or container while avoid direct contact between them;
6. Secure the sample container lid.
7. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.3.3 Sampling with a Pump and Tubing

The following procedure shall be used for the collection of a surface grab sample using a pump and dedicated tubing:

1. Decontaminate the pump in accordance with SOP ENV-04-04, as appropriate.
2. Lower the tubing or pump intake to a depth of 6 to 12 inches below the water surface, where possible. The pump intake or intake tubing shall be maintained below the water surface during sample collection.
3. Pump several tubing volumes through the system prior to collecting the first sample.
4. If field preservation is required, ensure the preservative is present in the sample container prior to filling the sample container;
5. Fill the sample container(s) from the discharge tubing.
6. Secure the sample container lid.
7. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.4 Depth Grab Sample Collection Procedures

Depth grab samples shall be collected from at least below the top 12 inches of the water column to within 6 inches of the stream or impoundment bed, at depths to satisfy the DQOs specified by a Site-Specific Work Plan and/or determined in the field based on field encountered conditions (i.e., stratification, water column depth, etc.). Specific sample collection procedures for depth grab samples are presented below. If sample collection is performed by wading in the stream, the location shall be approached from a downstream location

and efforts made to minimize sediment disturbance, which has the potential to bias the sample. Wading shall be deemed acceptable if a noticeable current is present and the samples can be collected from a location upstream of the field personnel. The field personnel shall approach the sample location slowly from downstream in order to minimize sediment disruption and sample corruption.

5.4.1 Sampling with Kemmerer, Niskin, or Van Dorn Type Devices

To the extent practical, devices constructed of stainless steel or Teflon or with Teflon-coated surfaces shall be used. Samplers that are constructed of plastic and rubber shall not be used to collect samples for extractable organics or volatile organic compound (VOC) analysis. The following procedure shall be used to collect depth grab samples using these devices:

1. Decontaminate the device in accordance with SOP ENV-04-04;
2. Measure the water column to determine the maximum depth and sampling depths;
3. Mark the line attached to the device with depth increments so that the sampling depth can be accurately recorded;
4. Slowly lower the device to the desired sampling depth in a manner that minimizes sediment disturbance;
5. At the desired depth, send the messenger weight down to trip the closure mechanism;
6. Slowly retrieve the device;
7. Rinse the outside of the device with distilled water;
8. Remove the sample container cap or lid and fill the container via the discharge tube;
9. If field preservation is required, follow Step 6 through Step 9 in Section 5.3.1 above; otherwise, proceed to Step 10 below.
10. Secure the sample container lid.
11. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.4.2 Sampling with Double Check-Valve Bailers

If DQOs do not necessitate a sample from a strictly discrete interval of the water column, a double check-valve bailer may be used. The following procedure shall be used to collect a depth grab sample with a double check-valve bailer:

1. Decontaminate the bailer in accordance with SOP ENV-04-04, or use a clean disposable bailer at each sampling location.
2. Measure the water column to determine the maximum depth and sampling depths.
3. Mark the line attached to the bailer with depth increments so that the sampling depth can be recorded.
4. Slowly lower the bailer to the desired sampling depth in a manner that minimize sediment disturbance.
5. Slowly retrieve the bailer.
6. Rinse the outside of the bailer with distilled water.
7. Remove the sample container cap or lid and fill the containers via the discharge port.
8. If field preservation is required, follow Step 6 through Step 9 in Section 5.3.1 above; otherwise, proceed to Step #9 below.
9. Secure the sample container lid.
10. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.4.3 Sampling with a Pump and Tubing

The following procedure shall be used for the collection of a depth grab sample using a pump and dedicated tubing:

1. Decontaminate the pump in accordance with SOP ENV-04-04, as appropriate.
2. Measure the water column to determine the maximum depth and sampling depths.
3. Secure the pump intake or intake tubing to a stiff pole or weight.
4. Lower the pump intake or intake tubing to the desire sample depth.
5. Pump several tubing volumes through the system prior to collecting the first sample.
6. Remove the sample container cap or lid and fill the sample container from the discharge tubing.
7. If field preservation is required, follow Step 6 through Step 9 in Section 5.3.1 above; otherwise, proceed to Step 8 below;
8. Secure the sample container lid.
9. Label the sample container in accordance with SOP ENV-03-01 and place in cooler with double-bagged ice for in preparation for transportation to the analytical laboratory.

5.5 Sampling for Biological Analysis

When sampling for biological or bacteriological examination, the procedures described above shall be followed with one exception, unless otherwise specified in the Site-Specific Work and/or FSP. Samples shall be collected in bottles properly sterilized and protected against contamination. As with any sample collection procedure, while the bottle is open, both the bottle and stopper shall be protected against contamination from other sources and the bottle closed at once following sample collection.

6.0 DOCUMENTATION

Sample information, labeling, and custody control shall be performed in accordance with requirements specified in SOP ENV-03-01 and ENV-03-02. Sampling activities shall be recorded in the field logbook and/or on the appropriate field form as specified in SOP ENV-01-01 or as required by the Site-Specific Work and/or FSP.

7.0 REFERENCES

ASTM International, D3977-97 (2002), Standard Test Methods for Determining Sediment Concentration in Water Samples.

ASTM International, D4581-86 (2005), Guide for Measurement of Morphologic Characteristics of Surface Water Bodies.

ASTM International, D5073-02, Practice for Depth Measurement of Surface Water.

Florida Department of Environmental Protection, February 2004, DEP-SOP-001/01 FS 2100 Surface Water Sampling.

USEPA, November 1994, SOP 2013: Surface Water Sampling, Rev. 0.0, Environmental Response Team.

USEPA, July 2002. Standard Operating Procedures for the Collection of Chemical and Biological Ambient Water Samples. Revision 1.

USEPA. 40 CFR Part 136.3 (e) Table II

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-09-02

STREAMFLOW MEASUREMENT Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes guidelines for the calculation of velocity and stream discharge measurements in rivers and streams. Procedures are given for measurements that can be conducted from water vessels (i.e. boats or barges), bridges (if traversing a representatives section of the river) or by wading with assistance from other field personnel working from the stream bank.

2.0 EQUIPMENT AND MATERIALS

- Flow Meter;
- Top-setting wading rod (measured in tenths of a foot);
- Tape measure or tagline (long enough to traverse the stream bed)
- Stakes to anchor tape to shore;
- Mallet or hammer;
- Field logbook and applicable field data sheets;
- Pen(s) with waterproof, non-erasable ink;
- Waders; and
- Personal protective equipment.

3.0 HEALTH AND SAFETY WARNINGS

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Work on water requires that marine health and safety procedures are used in addition to standard health and safety procedures. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and

subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 GENERAL PROCEDURES

4.1 Standard Field Procedures

Streamflow measurements shall be conducted only by a trained technician. Field data and observations associated with streamflow measurements shall be documented in accordance with SOP ENV-01-01, if not otherwise specified in this SOP. All activities should be recorded in a field logbook and/or on a streamflow measurement field form.

4.2 Site Selection

The stream transect location is a critical component of streamflow measurement. A site where the stream is most consistent in depth and flow rate across its width is easier to sample and provides more accurate results. Flow sites should be free of eddies, slack water, and excessive turbulence. Avoid areas where islands, ox-bows, piles of debris, aquatic plants or tributaries are present.

4.3 Flow Meter Selection

Several flow meters are available for measuring stream velocity. Some specific meters are the Price Model #1210 (AA); Price Model #1205 (Pygmy) for small, shallow streams; the March-McBirney 201D; and the March-McBirney Flo-Mate 2000. Selection of an appropriate flow meter will depend on the width and depth of the stream being measured, as well as stream features and irregularities. Additional guidance for selection of flow meters may be given in the Site-specific Work Plan.

4.4 Calculation of Stream Discharge

Stream discharge is determined by multiplying the mean stream velocity by the cross sectional area of the flow. The general form of the discharge equation is:

$$Q = A \text{ x } v$$

Where: Q = discharge in cubic feet per second (cfs)
A = cross section area of the channel at the transect in square feet (ft^2)
v = mean water column velocity at the transect in feet per second (ft/s)

To measure discharge (Q), a transect of the stream is divided into subsections and velocity, width and depth measurements are made within each subsection. Discharge of the stream at the transect is calculated by a form of the general equation:

$$Q = \sum_{i=1}^{n} (A_i \, x \, v_i)$$

Where: Q = discharge (cfs)
A_i = cross-sectional area of subsection I (ft^2)
v_i = velocity of subsection (ft/s)

A variation of this equation for mid-section method from Rantz (1982) is presented is Section 7.0 below. Other variations can be found in references listed at the end of this SOP and may be used as specified in the Site-specific Work Plan.

5.0 FIELD MEASUREMENT PROCEDURES

1. Calibrate the flow meter as specified in the manufacturer's instructions.
2. Attach the flow meter to the top set wading rod.
3. Measure the width of the stream at the selected transect location is measured by staking one end of the tape measure or pre-measured and incrementally marked tagline on the right bank. Pull the tape measure across the stream keeping it perpendicular to the flow and stake it on the left bank or use GPS to establish a transect location if sampling from a vessel. Measure the width of the stream from left edge of water (LEW) to right edge of water (REW). LEW is defined as the point where water flow begins on the transect as you face downstream. REW is where water flows ends on the transect.

4. Determine the spacing of transect subsections to be used for velocity measurements. Each subsection should have a width of 5% to 10% of the stream width. For an accurate measurement of discharge, velocity should be measured in 20 to 30 subsections. If inconsistencies in flow rate or streambed topography are present, the number and sizes of subsections can be adjusted to accommodate the differences. Additional guidance on subdividing the transect may be given in the Site-specific Work Plan.
5. Determine the mid-point of each subsection. Use a cumulative measurement. If the stream is 30 feet wide with 20 subsections, the first mid-point is located at 0.75 feet from LEW, the second is located at 2.25 feet from LEW, etc. Draw a rough sketch of the transect with subsections and mid-point measurements in the field logbook and/or on the appropriate field form.
6. Begin the velocity and depth measurements at the first subsection mid-point as measured from the LEW. Measure the total depth of water using the scale on the lower portion of the wading rod or 2-inch diameter graduated aluminum pole. Single indentations on the rod indicate 0.1 foot, double indentations indicate 0.5 foot and triple indentations indicate 1.0 foot. Depending on water depths, velocity measurements will be taken at one or two depths as follows:
    - Depths ≤ 2.5 feet – one measurement is taken at 60% of the total depth when measured from the surface of the water. To set the sensor of the flow meter at 60% of the depth, line up the foot scale on the sliding rod with the tenth scale on the top of the depth gauge rod. For example, if the first subsection is 1.5 feet deep, line up the 1 foot indentation on the sliding rod with the 5 on the tenth scale on the depth gauge rod.
    - Depths > 2.5 feet – two measurements are taken: one at 20% of the total depth and one at 80% of the total depth when measured from the surface of the water. To set the 20% depth point, multiply the depth of the water by two and move the sliding rod so that the foot measurement on it lines up with the tenth of a foot measure on the depth gauge rod. For example, if the first subsection is 2.8 feet deep, twice the depth is 5.6 feet. Line up the number 5 on the sliding rod with the 6 on the depth gauge rod. To set the 80% depth point, divide the depth of the water by two and move the sliding rod to line up with the depth gauge rod based on the results. For example, 2.8 feet divided by 2 equals 1.4 feet. Line up the number 1 on the sliding rod with the 4 on the depth gauge rod. The average of the two velocity measurements are used in the flow calculation.

Take the velocity measurement(s) following the manufacturer's instructions and record them in the field logbook or on the field log form. Proceed to the next subsection of the transect and repeat the procedure across the stream towards the REW.

7. If required, continue to next transect location and repeat the measurement procedures.

6.0 DISCHARGE CALCULATIONS

Calculate the discharge in each transect subsection by multiplying the average velocity (>2.5-foot depth subsection) or single velocity (≤ 2.5-foot depth) by the subsection width and average depth using the equation:

$$Q = (\frac{D_1 + D_2}{2})(\frac{v_1 + v_2}{2})W_1 + ... + (\frac{D_m + D_n}{2})(\frac{v_m + v_n}{2})W_m$$

Where: Q = discharge (cfs)
v = velocity of subsection (ft/s)
W = width of subsection (ft)

Note: The first and last subsections are located at the edges of the stream and have a depth and velocity of zero (D_1, D_n, v_1 and v_n).

7.0 QUALITY ASSURANCE/QUALITY CONTROL

7.1 Equipment Calibration, Operation, and Maintenance

All field equipment shall be calibrated, operated, and maintained in accordance with SOP ENV-02-01 and manufacturer's instructions.

7.2 Calculations

All calculations shall be checked by another person for correctness and use of appropriate equations. Any corrections required will be made by the person originally performing the calculations. These corrections will be checked for correctness and approved for publication.

8.0 REFERENCES AND ADDITIONAL RESOURCES

Carter, R. W. and Davidian, J., 1969, General Procedure for Gaging Streams: Techniques of Water Resources Investigations of the U.S. Geological Survey, Book 3.

California Department of Pesticide Regulation, Environmental Monitoring Branch, 2004, Standard Operating Procedure for Determining Wadable Stream Discharge with Price Current Meters, SOP Number: FSWA009.01.

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Florida Department of Environmental Protection, Bureau of Watershed Management, Watershed Assessment Section, February 2004, FT 1800 Field Measurement of Water Flow and Velocity. DEP-SOP-001/01.

USEPA, Region 6, January 2003, Standard Operating Procedure for Streamflow Measurement.

USEPA, April 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

SOP SERIES SAS-10

WITHHELD - NOT RELEVANT TO STUDY ACTIVITIES

SOP SERIES SAS-11

SOIL VAPOR SAMPLING AND MEASUREMENT PROCEDURES

STANDARD OPERATING PROCEDURE NO. SAS-11-01

SUB-SLAB SAMPLE PORT INSTALLATION, SAMPLING, AND ABANDONMENT Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for installation and sampling of sub-slab sample ports. Soil gas sampling is a useful tool to evaluate the potential for vapor intrusion at sites with subsurface chemical impacts and existing buildings. Sub-slab sampling is conducted directly beneath the building's slab to provide measurements of soil gas that may potentially enter a building.

2.0 EQUIPMENT AND MATERIALS

- Rotary hammer drill (or equivalent) with 1-inch and 5/16-inch diameter bits;
- Hand tools, including a hammer, needle-nose pliers, and trowel;
- "T" Swagelok® (compression) or equivalent fitting;
- 3-way and 2-way stopcocks;
- ¼-inch O.D. Teflon™ tubing;
- Tedlar™ bags;
- Plastic helium shroud;
- Broom and dust pan or hand vacuum;
- Beeswax;
- Nitrile gloves;
- Summa™ canisters with flow controllers, particulate filters, vacuum gauges, and shipping container;
- Sample labels;
- Chain of custody forms and seals;
- Field air monitoring instruments, as specified in the Work Plan (e.g. photoionization detector (PID), multi-gas monitors, etc.)
- Location markers (e.g. pin flags, wooden stakes, flagging tape, etc.);

- Asphalt cold patch or cement, as appropriate for site restoration; and
- Field logbook and/or appropriate field forms

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

Variations in chemical-specific characteristics, geologic conditions, and atmospheric influences can affect soil-gas sampling results. For this reason, it is important to understand factors the may influence the reported data when collecting soil-gas data. In all cases, site-specific factors should be carefully evaluated prior to initiation of sampling to obtain representative soil-gas data.

Prior to any soil-gas sampling, soil type must be evaluated for suitability of sampling. Soils with smaller grain sizes have smaller pore spaces and are less permeable, which may reduce the ability for soil gas to be released from the subsurface. For example, clays have the smallest grain size and significantly restrict soil gas migration. Soil moisture also limits the ability for soil gas to be released from the subsurface because moisture trapped in the pore space of sediments can inhibit or block soil-gas flow. Seasonal and geographical variations in soil moisture content can affect air permeabilities. In addition, manmade and naturally occurring preferential pathways (e.g. utility corridors, lenses of coarse-grained materials within fine-grained materials, etc.) may also affect soil-gas migration and shall be considered prior to soil-gas sampling.

Reliability of soil-gas sampling may be improved by using fixed probes and by ensuring that leakage of atmospheric air into the samples is avoided during purging or sampling. To avoid dilution of the sampling region from leakage, the minimum purge volume deemed adequate to flush the sampling system should be removed, and soil-gas samples should be collected from the most permeable zones in the vadose zone when possible. Site-specific information concerning soil lithology, grain size analysis, soil moisture, and soil-gas permeability may be obtained by performing three soil borings in the immediate area of the sampling locations in advance of the soil-gas sampling. In addition, previous site investigation sample results, when available, should be used to determine the placement of the soil-gas sampling locations.

Since oxygen, carbon dioxide, and nitrogen can be sampled using a multi-gas monitor to give real-time results, parallel analysis of oxygen, carbon dioxide, and nitrogen in soil-gas may also be used to help assess the reliability of a given sample result.

5.0 EXECUTION

The active soil-gas sampling approach consists of withdrawing an aliquot of soil gas from the subsurface, followed by the analysis of the withdrawn gas. Active soil-gas systems use mechanical equipment to create a small-diameter hole in the ground and then use a vacuum to "actively" withdraw a soil gas sample through Teflon tubing within the vadose zone. The soil gas sample is collected in a Summa canister and sent to a laboratory for analysis. Samples are analyzed using USEPA's Ambient Air Compendium Method TO-15 (USEPA, 1999) for determining organic compounds in ambient air. The results provided by active soil-gas systems are quantitative and are reported in units of concentration per volume (micrograms per cubic meter [$\mu g/m^3$], or parts per billion volume [ppb_v]).

The following active soil-gas sampling methodologies (port installation and sampling) are based on established methods as outlined in the *USEPA Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (USEPA, 2002) and the ASTM International (ASTM) standard guide D 5314-01 (ASTM, 2001). Additional guidelines were provided from the San Diego County Site Assessment and Mitigation (SAM) Manual, "Overview of Soil Vapor Survey Methods" (San Diego County, 2002 and 2004) and the California Regional Water Quality

Control Board (CRWQCB), Los Angeles Region (LARWQCB) (CRWQCB, 2002 and 2003) and the Department of Toxic Substances Control (DTSC) guidelines (DTSC, 2004).

5.1 PRE-SAMPLING ACTIVITIES

Before starting field activities, attempts should be made to obtain as-built drawings for each building to determine foundation thickness and utility locations. The as-built drawings should be used to finalize probe placement in each of the buildings.

Prior to installing the sub-slab vapor probes, a building survey will be completed. The purpose of the building survey is to document general building structural and use information, including describing the general building uses, presence/absence of wells or sumps, presence/absence of a basement, and documenting potential indoor VOC sources by identifying what chemicals are used or are present in the building. Rooms where probes are proposed should be screened with a PID. If available, Material Safety Data Sheets (MSDSs) for products used in the building will be obtained. The initial building survey will also include identifying the points at which subsurface utilities enter the building. A Building Questionnaire (See Attachments) form should be used for the initial building survey.

5.2 SUB-SLAB SOIL VAPOR PROBE CONSTRUCTION AND INSTALLATION

The sub-slab soil vapor probe installation procedures were derived primarily from the USEPA's *Draft Standard Operating Procedure for Installation of Sub-Slab Vapor Probes and Sampling Using EPA Method TO-15 to Support Vapor Intrusion Investigations* (USEPA, 2002). The sub-slab probes described in the USEPA SOP and in the following procedures are permanent sampling probes that will remain in place after completion of the sampling event. Permanent sampling probes are preferred because they provide higher quality and more consistent data. The individual probes will be removed and the holes sealed upon determining that further sub-slab soil vapor sampling will not be required at a given location.

Use a rotary hammer drill and a clean drill bit to create a shallow (2.5 centimeters (cm) or 1 inch) outer hole that partially penetrates the slab. Areas of visible staining or known previous chemical spills will be avoided. Use a small brush and dust pan or hand vacuum to collect concrete dust and cuttings from the hole. Since the outer hole does not penetrate the floor slab, a dedicated drill bit is not required.

After completing the outer hole, a rotary hammer drill will be used to create a smaller diameter inner hole (0.8 cm or 5/16 inch) through the remainder of the slab and approximately 7 to 8 cm or 3 inches into sub-slab material. The inner hole should be drilled using a dedicated drill bit. Drilling into sub-slab material will create an open cavity which will prevent obstruction of probe inlets during vapor sampling. After completing drilling, the outer hole should be cleaned using a towel moistened with deionized water to increase the potential of obtaining a good seal during cement application.

Probes should be constructed of stainless steel, brass, or Teflon™ tubing and fittings to ensure that construction materials are not a source of VOCs. Metal probe materials should be cleaned with detergent and water prior to installation to remove cutting oils that may have been used in manufacturing. Once the thickness of the slab is known, stainless steel or Teflon™ tubing should be cut to ensure that probes "float" in the slab to avoid obstruction of the probe with sub-slab material. Construct sub-slab vapor probes from small diameter (0.64 cm or 1/4 inch outer diameter x 0.46 cm or 0.18 inch inner diameter) chromatography grade 316 stainless steel or brass tubing and stainless-steel or brass compression to thread fittings (e.g., 0.64 cm or 1/4 inch outer diameter x 0.32 cm or 1/8 inch NPT (National Pipe Tapered) Swagelok® female thread connectors). The probes will be closed using 0.32 cm (1/8 inch) recessed stainless steel or brass socket plugs.

Set sub-slab vapor probes in holes such that the fittings rest at the base of the outer hole and the top of the probes are completed flush with the slab. Each probe will have recessed stainless steel or brass plugs so as not to interfere with day-to-day use of buildings. Mix a quick-drying portland cement that expands upon drying (to ensure a tight seal) with deionized water to form a slurry and inject or push into the annular space between the probe and outside of the outer hole. Allow cement to cure for at least 24 hours prior to sampling.

5.3 SUB-SLAB SAMPLING PROCEDURES

Subsurface vapor will not be sampled if measurable precipitation or irrigation near the sampling location has occurred within the previous five days. The increased soil moisture can reduce soil permeability and cause the soil vapor sample results to be biased low.

5.3.1 Sample Train Assembly

Samples will be collected from the previously installed soil vapor probes using evacuated batch-certified 1 liter (L) or smaller Summa™ canisters equipped with dedicated flow regulators and integrated particulate

filters. A flow regulator/particulate filter and vacuum gauge will be attached to each canister as described in the Summa Canister Instructions provided by the laboratory. Canisters, flow regulators/particulate filters, and vacuum gauges will be supplied by the laboratory.

A helium shroud, consisting of a solid plastic container with a height of less than 6 inches and a volume less than 6L, will be placed around the exposed portion of the soil vapor probe. A dedicated stainless-steel fitting and Teflon™ tubing will be connected to the soil vapor probe while passing through a ¼-inch hole in the side of the helium shroud, no more than three inches above the base of the shroud. All fittings and tubing will be dedicated in order to avoid cross-contamination between probes. A second length of Teflon™ tubing will be inserted into the side of the shroud and connected to a helium cylinder on the outside of the shroud. The Teflon™ tubing attached to the soil vapor probe will be connected to a two-way stopcock. The two-way stopcock will be attached to a three-way stopcock. The other two outlets on the three-way stopcock will be attached to Teflon™ tubing. The tubing from one outlet of the three-way stopcock will be connected to the Summa™ canister assembly, and the tubing from the other outlet will be connected to a 1L Tedlar™ (or equivalent) bag. The Tedlar™ bag will be placed in a lung box. An air pump will be used to evacuate the air inside the lung box and collect a sub-slab soil gas sample in the 1L Tedlar™ bag. A new pair of Nitrile gloves should be worn while connecting the sample assembly for each soil vapor probe. The total length of Teflon™ tubing should not exceed 5 feet.

When collecting duplicate or QA split samples, two separate canister assemblies are connected using a stainless steel “T” fitting, and the “T” fitting is then connected to the three-way stopcock using Teflon™ tubing. The “T” fitting will be provided by the laboratory.

5.3.2 Helium Leak Testing

The purpose of the chemical leak test is to ensure that the sub slab sample port and probe assembly is properly set and not leaking. A leaking sub slab probe assembly could result in a leakage of indoor air into the sub slab sample, potentially biasing the sample. Prior to sampling, a chemical leak test will be performed using helium as a tracer gas. The ambient air inside the shroud will be replaced with helium graded at 99.9 percent purity or higher until the atmosphere consists of a minimum of 20 percent helium. It should be noted that concentrations of 60 percent to 80 percent helium have routinely been observed in the shroud during prior field testing. This will be accomplished by inserting Teflon™ tubing through a ¼ inch hole in the shroud and

attaching the other end to the helium canister. The helium canister will then be opened, and the shroud atmosphere will be continuously monitored by a Dielectric Technologies Model MGD-2002 Multi-Gas Detector (or equivalent) until the percentage of helium inside the shroud reaches a minimum of 20 percent and the readings on the Multi-Gas Detector (or equivalent) stop increasing. The final helium concentration inside the shroud will be recorded on the Field Data Air Sampling Form. The final helium concentration inside the shroud will be multiplied by 10 percent (0.1) to determine the allowable concentration of helium in the Tedlar™ bag sample. Both the final helium concentration inside the shroud and the calculated allowable concentration in the Tedlar™ bag will be recorded on the Field Data Air Sampling Form (See Attachments).

After the target atmosphere is established, the two-way and three-way stopcocks will be opened to the lung box, which contains a 1 L Tedlar™ bag. An air pump attached to the lung box via Teflon™ tubing will be used to evacuate the existing air inside the lung box, which will in turn cause the 1 L Tedlar™ bag to fill. Once filled, the 1 L Tedlar™ bag will be removed from the lung box and the air inside will be measured using the Model MGD-2002 Multi-Gas Detector (or equivalent) for the presence of helium. The concentration of helium measured inside the Tedlar™ bag will be recorded on the Field Data Air Sampling Form. If the concentration of helium in the sample is below the calculated allowable concentration (i.e., less than 10 percent of the concentration inside the helium shroud), proceed with the mechanical leak test and sample collection as described in Sections 5.3.3 and 5.3.4.

Corrective actions to mitigate leaks in the sub-slab soil vapor probe will be performed when the helium concentration in the Tedlar™ bag sample exceeds 10 percent of the starting concentration in the helium shroud. Corrective actions will be performed in the field and will initially involve resealing the probe base with beeswax and repeating the helium leak test. If resealing and retesting fails to produce acceptable leak test results after two attempts, the probe will be abandoned and a new probe will be installed. Samples will not be collected for submittal for laboratory analysis when the helium concentration in the Tedlar™ bag sample exceeds 10 percent of the starting helium concentration in the shroud.

5.3.3 Mechanical Leak Testing

The mechanical leak test will be performed immediately after completing the helium leak test. The mechanical leak test will be completed by closing the two-way stopcock and turning the valve on the three-

way stopcock to close the tubing connected to the lung box assembly. This will close the connection between the two-way stopcock and the lung box assembly and open the connection between the two-way stopcock and the Summa™ canister. Vacuum test the connections between the Summa™ canister and stopcock by opening the canister valve to place a test vacuum on the assembly for 10 minutes. The start time and initial vacuum, as well as the stop time and final vacuum, will be recorded on the Field Data Air Sampling Form and in the field logbook. If gauge vacuum can not be maintained for 10 minutes, work shall be suspended and all fittings in the sample assembly will be checked. Retest the sample assembly. If vacuum still can not be maintained by 10 minutes, sampling activities will be discontinued until leak can be identified and addressed.

If gauge vacuum was maintained for 10 minutes, close the canister valve and immediately proceed with sample collection as described in Section 5.3.4. Since the fitting that connects the tubing from the sub-slab probe to the two-way stopcock cannot be leak tested through either the helium or mechanical leak tests, this fitting will be sealed with Teflon™ tape and beeswax.

5.3.4 Sample Collection

Sample location information and meteorological conditions (temperature, barometric pressure, wind speed/direction, and relative humidity) shall be recorded on a Field Data Air Sampling Form. Meteorological data will be obtained online from the nearest National Weather Service measuring station. Digital photos will be taken of each sample location and sample assembly.

Open the two-way stopcock connecting the Summa™ canister assembly to the soil vapor probe. Open the canister valve to begin sample collection. The time and initial vacuum when sample collection starts shall be recorded on the Field Data Air Sampling Form. The laboratory-provided flow regulators will be calibrated for a 5- to 10-minute sample duration, which correlates to a flow rate of 100 to 200 mL/min. Close the sample canister valve when the vacuum gauge indicates approximately 3-5 inches Hg (mercury) of vacuum remain in the canister. Sample collection should take approximately 5 minutes for a 1L Summa™ canister connected to a 200 mL/min flow regulator. The time sample collection was stopped and final vacuum shall be recorded on the Field Data Air Sampling Form. Remove the flow regulator/particulate filter and vacuum gauge assembly and replace the laboratory-supplied brass plug on the canister. Disconnect the sample tubing assembly and replace the plug on the soil vapor probe.

Label the sample canister and record on the COC the sample name, date and time the sample was collected, the canister and flow controller serial numbers, and the final vacuum gauge reading. Samples shall not be chilled or subjected to extreme temperature or pressure fluctuations. Samples will be shipped to the laboratory for analysis of VOCs by USEPA Method TO-15.

5.3.5 Quality Control

Trip blanks, field duplicates, and QA samples will be collected during soil vapor sampling activities. Field duplicates and QA split samples will be collected at the rate of one duplicate/QA sample per 10 soil vapor samples (i.e., 10 percent). Normally, field duplicates and QA samples are collected from the same location; however, the "T" connectors used to collect duplicate samples can not be used to collect three simultaneous samples. Therefore, the duplicate and QA samples will be collected from separate locations.

A trip blank, consisting of an unopened evacuated canister, will be sent with each shipment of sub-slab vapor samples. Trip blanks can consist of either unopened fully evacuated canisters or canisters that have been fully charged with zero grade air by the laboratory. Since a fully charged canister has no vacuum with which to pull contaminants into the canister, a fully evacuated canister has a better likelihood of capturing potential transit-related contamination. The trip blank will be provided by the laboratory.

6.0 EQUIPMENT DECONTAMINATION PROCEDURES

All decontamination will be performed according to SAS-04-04.

7.0 INVESTIGATION-DERIVED WASTE (IDW)

The sub-slab vapor probe installation and sampling will generate small amounts of solid IDW including concrete dust, gloves, drill bits, and tubing. This material will be bagged and disposed of as a municipal waste in accordance with applicable regulations. No liquid IDW will be generated. Further discussion of IDW can be found in Section 9 of the *Multi-Site Field Sampling Plan, Former Manufactured Gas Plant Sites, Revision 3", February 20, 2008.*

8.0 REFERENCES

ASTM International, 2001, ASTM Standard D 5314-92 (2001) Standard Guide for Soil Gas Monitoring in the Vadose Zone.

California Regional Water Quality Control Board, Los Angeles Region, 2002, General Laboratory Testing Requirements for Petroleum Hydrocarbon Impacted Sites.

California Regional Water Quality Control Board, Los Angeles Region, 1997, Interim Guidance for Active Soil Gas Investigation, Advisory issued January 28, 2003.

Department of Toxic Substance Control-California Environmental Protection Agency, 2004, Interim Final Guidance to the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air, Revised February 7, 2005.

San Diego County, Site Assessment and Mitigation (SAM) Manual, "Overview of Soil Vapor Survey Methods" Final Draft 8/20/2002.

San Diego County, 2004, Site Assessment and Mitigation (SAM) Manual, "Overview of Soil Vapor Survey Methods".

United States Environmental Protection Agency (USEPA), 2002. *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance).* Office of Solid Waste and Emergency Response. November 29.

USEPA, 1999, Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected In Specially-Prepared Canisters and Analyzed By Gas Chromatography/Mass Spectrometry GC/MS) in *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, 2nd Ed., EPA Publication 625/R-96/010b.

STANDARD OPERATING PROCEDURE NO. SAS-11-02

POST-RUN TUBING SYSTEM SAMPLING Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for Post-Run Tubing (PRT) System sampling. Soil-gas (soil vapor) sampling is a useful tool to evaluate potential subsurface soil and groundwater impacts that can partition into gas and affect indoor air quality. PRT sampling is conducted above the water table at a depth of five feet below ground surface (bgs) or deeper to provide measurements of soil-gas that may potentially enter a building and affect indoor air quality.

2.0 EQUIPMENT AND MATERIALS

- Rotary hammer drill (or equivalent) with a 1 3/8-inch diameter bit;
- Retractable gas vapor tip (GVP);
- Expendable GVP replacements;
- Hand Tools, including a hammer, needle-nose pliers, and trowel;
- Tubing receptacle;
- Teflon compression fittings to connect sampling points at “T” connection;
- “T” Swagelok (compression) or equivalent fitting;
- Gas sampling pump capable of extracting 200 milliliters per minute (mL/min);
- 4-way Teflon micro-valve;
- 1/4-inch O.D. Teflon tubing;
- VOC-free caulk;
- Nitrile gloves;
- Summa canisters with flow controllers, vacuum gauge, and shipping container;
- Sample labels;
- Chain of custody forms and seals;

- Field air monitoring instruments, as specified in the Work Plan (e.g. photo ionization detector, multi-gas monitors, etc.);
- Location markers (e.g. pin flags, wooden stakes, flagging tape, etc.);
- Granular bentonite;
- Asphalt cold patch or cement, as appropriate for site restoration;
- Decontamination materials;
- DOT-specified 55-gallon drum; and
- Field logbook and/or appropriate field form(s);

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

Variations in chemical-specific characteristics, geologic conditions, and atmospheric influences can affect soil-gas sampling results. For this reason, it is important to understand factors the may influence the reported data when collecting soil-gas data. In all cases, site-specific factors should be carefully evaluated prior to initiation of sampling to obtain representative soil-gas data.

Prior to any soil-gas sampling, soil type must be evaluated for suitability of sampling. Soils with smaller grain sizes have smaller pore spaces and are less permeable, which may reduce the ability for soil gas to be released from the subsurface. For example, clays have the smallest grain size and significantly restrict soil gas migration. Soil moisture also limits the ability for soil gas to be released from the subsurface because

moisture trapped in the pore space of sediments can inhibit or block soil-gas flow. Seasonal and geographical variations in soil moisture content can affect air permeabilities. In addition, manmade and naturally occurring preferential pathways (e.g. utility corridors, lenses of coarse-grained materials within fine-grained materials, etc.) may also affect soil-gas migration and shall be considered prior to soil-gas sampling.

Reliability of soil-gas sampling may be improved by using fixed probes and by ensuring that leakage of atmospheric air into the samples is avoided during purging or sampling. To avoid dilution of the sampling region from leakage, the minimum purge volume deemed adequate to flush the sampling system should be removed, and soil-gas samples should be collected from the most permeable zones in the vadose zone when possible. Site-specific information concerning soil lithology, grain size analysis, soil moisture, and soil-gas permeability may be obtained by performing three soil borings in the immediate area of the sampling locations in advance of the soil-gas sampling. In addition, previous site investigation sample results, when available, should be used to determine the placement of the soil-gas sampling locations.

Since oxygen, carbon dioxide and nitrogen can be sampled using a multi-gas monitor to give real-time results, parallel analysis of oxygen, carbon dioxide and nitrogen in soil-gas may also be used to help assess the reliability of a given sample result.

5.0 EXECUTION

The active soil-gas sampling approach consists of withdrawing an aliquot of soil gas from the subsurface, followed by the analysis of the withdrawn gas. Active soil-gas systems use mechanical equipment to create a small-diameter hole in the ground and then use a vacuum to "actively" withdraw a soil gas sample through stainless steel or Teflon tubing within the vadose zone. The soil gas sample is collected in a Summa canister and sent to a laboratory for analysis. Samples are analyzed using USEPA's Ambient Air Compendium Method TO-15 (USEPA 1999) for determining organic compounds in ambient air. The results provided by active soil-gas systems are quantitative and are reported in units of concentration per volume (micrograms per cubic meter [$\mu g/m^3$], or parts per billion volume [ppb_v]).

The following active soil-gas sampling methodologies (emplacement, purging, sampling, leak testing, field screening, and abandonment) are based on established methods as outlined in the USEPA Standard Operating

Procedure (SOP) Number 2042 (USEPA 1996) and the ASTM International (ASTM) standard guide D 5314-01 (ASTM 2001). Additional guidelines were provided from the San Diego County Site Assessment and Mitigation (SAM) Manual, "Overview of Soil Vapor Survey Methods" (San Diego County 2002 and 2004) and the California Regional Water Quality Control Board (CRWQCB), Los Angeles Region (LARWQCB) (CRWQCB 2002 and 2003) and the Department of Toxic Substances Control (DTSC) guidelines (DTSC 2004 and 2005).

5.1 Summa Canister Preparation, QA/QC, and Set Up

A Summa canister is a stainless steel container which has had its internal surfaces passivated using a "Summa" process. The process uses an electro polishing step in conjunction with chemical deactivation. The overall process results in a chemically inert interior surface of the media which allows for the collection and subsequent analysis of samples containing very low concentrations of volatile organic compounds (VOCs). The Summa media is available in a number of different sizes. Typically, 6-liter Summa media are used for the collection of soil-gas because this volume should allow for low detection limits and facilitate more complex analyses.

Once the laboratory cleaning process is completed per USEPA SOP 1703 (USEPA 1994), the Summa media are prepared by the laboratory for use in the field. Each canister is evacuated to achieve a vacuum pressure of approximately -30 inches of mercury (" Hg). The pressure differential between the canister and atmosphere allows for the Summa media to sample without the use of a separate sample pump. Depending on the project requirements, either grab or integrated samples may be collected. The holding time (shelf life) for Summa canisters that have been prepared for use in the field is 30 days. If the canister has not been used within this time-period, it shall be returned to the contracted laboratory for re-conditioning.

Prior to collection, check all canisters for the proper certification issued by the analytical laboratory, as per USEPA SOP 1703 (USEPA 1994). The sampler shall complete the sample set-up of a Summa (or equivalent) canister prior to sample collection. Each six-liter (6.0 L) Summa (or equivalent) canister shall be fitted with a dedicated sample flow controller (regulator). After verification that the valve on the canister is in the "off" position, the brass cap shall be removed from the canister inlet fitting and the sample flow controller shall be attached to the canister inlet. The brass cap shall then be installed onto the inlet of the flow controller and

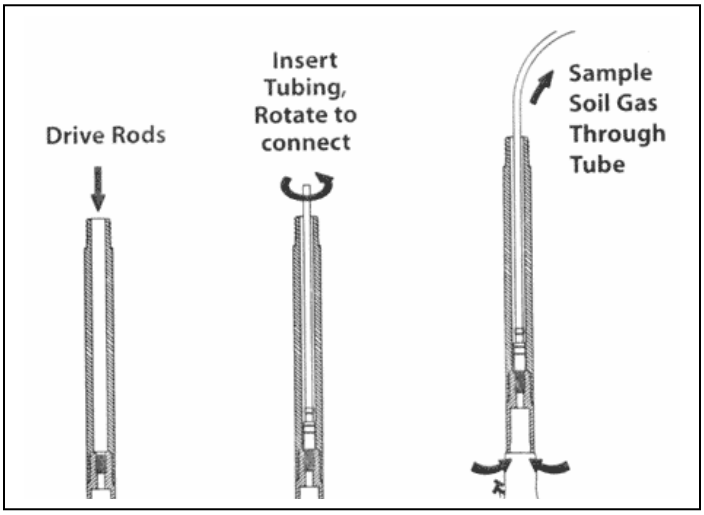
tighten. *Note: The sample flow controller (regulator) is a complete assembly that shall be attached directly to the canister.* The assembly shall then be leak-checked by opening the canister valve and noting the initial vacuum reading. The vacuum should indicate between -25" Hg and -30" Hg. The canister shall not be used if the starting vacuum is less than -25" Hg. The vacuum may fall a very small amount (1 to 2" Hg) due to the evacuation of the flow controller and then quickly stabilize. If the vacuum does not stabilize, the flow controller or associated fittings are leaking. If necessary, determine the location of the leak, and repair it accordingly. Any necessary repairs shall be document in the field logbook and/or on the appropriate field form.

5.2 Temporary Soil-Gas Probe Emplacement

The PRT system sampling methodology (see Figure below) shall be utilized to collect soil-gas samples within the vadose zone at a minimum sampling depth of 5 feet bgs.

FIGURE 1

PRT System Soil Gas Sampling



The sampler shall follow the general procedure for PRT system sampling as detailed below, unless otherwise required by the Site-Specific Work and/or Sampling Plan(s):

1. All subsurface activities shall only be performed following the clearance of each location for underground utilities in accordance with SOP ENV-05-01. In addition, a qualified contractor shall locate and mark private subsurface utilities.
2. Prior to drilling, the sampler shall clear vegetation or remove any floor coverings present, as appropriate.
3. If concrete or asphalt is present, a 1 3/8-inch diameter core hole shall be drilled through the entire thickness of the material until bare soil is reached.
4. Utilizing direct push technology, the sampler shall advance the 1.1-inch outer diameter (O.D.) expendable drive point attached to the 1.25-inch O.D. hollow push rods to target depth, which shall be a minimum of 5 feet bgs. Sample depths shall be chosen to minimize the transient effects of changes in barometric pressure, temperature, precipitation or breakthrough of ambient air from the surface to ensure that representative samples are collected. Sample depths shall be specified in the Site-Specific Work and/or Sampling Plan(s). No soil-gas sampling shall be conducted within 48 hours of a rainfall/irrigation event, due to excessive soil moisture content anticipated in the exposed surfaces.
5. Once the target depth is reached, the sampler shall insert the PRT and pull back the tool string approximately 3 inches (0.25 feet) thereby exposing the vapor inlet.
6. The sampler shall extend the 1/4-inch O.D. Teflon tubing through the slotted opening of the extension driver adapter, leaving 4 feet of tubing extending beyond the ground surface.
7. The sampler shall seal the end of the tubing with a protective cap to prevent air infiltration.
8. The sampler shall seal around the drive rods at the ground surface with hydrated bentonite slurry to prevent ambient air intrusion from occurring.
9. The sampler shall record the date and probe emplacement time in addition to the sample location in the field logbook and/or on the appropriate field form.

5.3 Pre-Sample Collection Activities

To help ensure a representative soil gas sample is being collected, the PRT system shall be purged of all ambient air and field screening shall be performed using a multiple gas detection monitor to establish that acceptable sampling conditions have been attained prior to sample collection. During probe emplacement, subsurface conditions are disturbed. To allow subsurface conditions to equilibrate, the sample system purge and soil gas screening shall not be conducted for at least 20 minutes following probe emplacement.

5.3.1 PRT System Purge

For a representative soil gas sample to be obtained, enough air shall be withdrawn prior to sample collection to purge the sampling system of all ambient air. The purge volume or "dead space volume" shall be estimated based on the internal volume of the tubing used and the annular space around the probe tip. Only the volume of air sufficient to flush the probe and sampling line shall be extracted before collecting the sample. The air contained in the Teflon tubing, vapor point holder and fittings forming the "sampling train" shall be evacuated using an air-sampling pump set at a rate not to exceed 200 ml/min. for the calculated period of time. System purging shall be performed consistently at each sampling location. An example of typical purge volumes and times is shown below.

Purge Volumes for PRT System

		5-foot Sample Depth	10-foot Sample Depth
One Purge Volume	**Volume**	46.14 ml	68.44 ml
	Time	13.8 sec	20.5 sec

The sampler shall calculate the volume of ambient air to be purged using the following factors and equations:

Purge Calculation Factors

1. Tubing (0.25-inch O.D., 0.17-inch I.D.) Volume = 4.46 ml per foot internal volume
2. Vapor Point Holder and Post Run Tubing Adapter Volume = 6 ml internal volume
3. Calculations assume a 4-foot section of tubing extends from the boring surface to the canister.

Volume Equation:

$A \times ((B \times C) + D) = E$

Where:

A = Number of Purge Volumes
B = 1 foot of tubing, 4.46 ml
C = Depth
D = Point Holder Volume, 6 ml
E = Volume to be purged

Time Equation:

$(E \div F) \times G = H$

Where:

E = Volume to be purged
F = Purge Rate, 200 ml/min.
G = 60 seconds
H = Purge Time in seconds at 200 ml/min.

5.3.2 Screening with Field Instruments

Analysis of oxygen, carbon dioxide and nitrogen in soil-gas samples can often be used to help assess the reliability of a given sample result. It is recommended that one or all of the aforementioned analytes be monitored using a multiple gas detector. After completion of the system purge, the monitoring instrument shall be connected at the "T" connection using the 0.25-inch O.D. Teflon tubing. When the monitoring instrument readings are stable or peak, the values shall be recorded in the field logbook and/or on the appropriate field form.

5.4 Sample Collection

After the sampling train has been adequately purged and field screened; samples shall be collected using a 6-liter Summa canister. Due to the disruption of soil gas equilibrium during purging and field screening, a period of equilibrium (at least 20 minutes in length) shall be allowed for subsurface conditions to equilibrate. To minimize the potential desorption of contaminants from the soil, Summa canisters should be filled at a rate that minimizes the vacuum applied to the soil and the turbulent flow at the probe tip. The San Diego County Site Assessment and Mitigation (SAM) Manual, "Overview of Soil Vapor Survey Methods" guidance (San Diego County 2004) requires this rate to be less than 200 ml/min. Summa canisters shall be filled using a flow regulator set at a constant rate within the range of 50 to 200 ml/min. The sampler shall follow the step-by-step procedure for PRT system sampling as outlined below, unless otherwise required by the Site-Specific Work and/or Sampling Plan(s):

1. The sampler shall attach an in-line particulate filter to the sample train, if deemed necessary given site conditions.
2. The sampler shall record the initial Summa canister vacuum reading from the line gauge in the field logbook and/or on the appropriate field form.
3. The valve on the Summa canister shall be opened allowing the soil-gas sample to be drawn into the canister by pressure equilibration. If condensation is observed in the sample tubing, the sample shall be discarded and the observation shall be documented in the field logbook and/or on the appropriate field form.
4. When the line gauge reads approximately -4 to -5" Hg remaining, the sampler shall close the Summa canister valve.

5. The sampler shall record the final Summa canister vacuum reading from the line gauge in the field logbook and/or on the appropriate field form.
6. The sampler shall fill out and attach the sample tag to the Summa Canister along with any additional information requested by the laboratory. This information shall also be recorded in the field logbook and/or on the appropriate field form.
7. The sample shall be packaged and shipped under chain of custody to the laboratory for analysis. The samples shall not be chilled during storage or transport to the laboratory. To minimize potential effects on the sample integrity, the sample analysis shall be conducted within 72 hours of the collection time.

5.5 Temporary Probe Removal and Borehole Abandonment

After sample collection, both the drive rod and tubing shall be removed. Soil-gas probes shall then be sealed using granular bentonite to fill the annular space of the hole. Soil-gas probes performed within residential or industrial/commercial structures shall also be filled with granular bentonite to the base of the core hole and a 1-inch thick caulk vapor seal shall be applied at the base of the core hole. The remainder of the core hole shall be filled with a neat cement (coarse aggregate free) mix or asphalt cold patch, as appropriate for site restoration. Any floor covering removed shall be replaced and the area restored to its pre-sampling condition to the extent practicable.

All investigation-derived waste is placed in Department of Transportation (DOT)-specified 55-gallon drums and properly labeled. The drums are placed in a secure on-site location for temporary storage prior to appropriate off-site disposal. Disposable sampling equipment and health & safety materials that are not visibly impacted are double-bagged in plastic trash bags and disposed of in a solid waste disposal location (i.e. trash dumpster or container).

6.0 QUALITY ASSURANCE/QUALITY CONTROL

6.1 Equipment Calibration, Operation, and Maintenance

Field air monitoring instruments, as specified in the Work Plan (e.g. photo ionization detector, multi-gas monitors, etc.) shall be calibrated, operated, and maintained in accordance with SOP ENV-02-01.

6.2 Leak Testing

Leakage during soil vapor sampling may dilute samples with ambient air and produce results that underestimate actual site soil vapor concentrations. Leak testing, if any is required, shall be based on data quality objectives as specified in the Site-Specific Work Plan. The following paragraph describes a direct leak detection method that is suitable for use during soil gas sampling.

Seal integrity can be evaluated directly using an inert tracer gas (e.g. laboratory grade helium). Inert gas selection shall be conducted in conjunction with the laboratory. The sampler shall construct an air tent using polyethylene sheet or assemble a commercially available air tent which encompasses the top of the probe/well casing and the entire sample train. During sampling, the tracer gas shall be allowed to flow around the sample train connections and the bentonite or grout seal at the ground surface. Following sample collection, the air tent shall be dismantled. The soil vapor sample shall be analyzed for inert trace gas in addition to the other requested analysis. If the tracer gas is detected in the soil vapor sample, the seal integrity was compromised and the analytical results, which are not representative of the stratigraphic unit or zone within the stratigraphic unit, shall be considered invalid.

6.3 Decontamination

Equipment decontamination procedures shall be implemented, in accordance with SOP ENV-04-04, to avoid cross-contamination between sampling locations.

6.3.1 Sample Probe Decontamination

Sample probe contamination shall be checked between each sample by drawing ambient air through the probe via a gas sampling pump and checking the response of the PID. If readings are higher than background, replacement or decontamination shall be necessary. Sample probes shall be decontaminated simply by drawing ambient air through the probe until the PID reading is at background. More persistent contamination shall be washed out using methanol and water, and then air drying. For persistent volatile contamination, use of a portable propane torch may be needed. If use of a portable propane torch is deemed necessary, the sampler shall use a pair of pliers to hold the probe while running the torch up and down the length of the sample probe for approximately 1 to 2 minutes. The probe shall be allowed cool before handling. When

using this method, the sampler shall wear gloves that are capable of preventing burns. Having more than one probe per sample team is advisable as it will reduce lag times between sample stations while probes are decontaminated.

6.3.2 Drive Rod Decontamination

After each use, drive rods and other reusable components are properly decontaminated to prevent cross contamination in accordance with SOP ENV-04-04.

6.3.3 Sample Train Decontamination

All elements of the sample train shall be dedicated to each sampling location to avoid potential cross-contamination. If visible contamination (soil or water) is drawn into the sampling train, it shall be changed immediately.

6.4 Duplicate Samples

If required by the Site-Specific Work and/or Sampling Plan(s), duplicate samples shall be collected with the addition of a "T" splitter being attached to the 4-way micro valve with a Teflon nut, and one canister attached to each end of the "T" Swagelok (compression) or equivalent fitting and in accordance with SOP ENV-04-03.

7.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2001, ASTM Standard D 5314-92 (2001) Standard Guide for Soil Gas Monitoring in the Vadose Zone.

California Regional Water Quality Control Board, Los Angeles Region, 2002, General Laboratory Testing Requirements for Petroleum Hydrocarbon Impacted Sites.

California Regional Water Quality Control Board, Los Angeles Region, 1997, Interim Guidance for Active Soil Gas Investigation, Advisory issued January 28, 2003.

Department of Toxic Substance Control-California Environmental Protection Agency, 2004, Interim Final Guidance to the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air, Revised February 7, 2005.

Hartman, Dr. Blayne; June 2002 - LUSTLine #41 Reevaluating the Upward Vapor Migration Risk Pathway, Synopsis: *An Updated Article on Upward Vapor Migration & a Recommended Sampling Protocol.*

Hartman, Dr. Blayne; October 2002 - LUSTLine #42 "How to Collect Reliable Soil Vapor Data for Risk Based Applications" Synopsis: *Part 1: Active Soil-Gas Method*

San Diego County, Site Assessment and Mitigation (SAM) Manual, "Overview of Soil Vapor Survey Methods" Final Draft 8/20/2002.

San Diego County, 2004, Site Assessment and Mitigation (SAM) Manual, "Overview of Soil Vapor Survey Methods".

USEPA, 1994, SOP 1703, Rev. 0.0, Summa Canister Cleaning Procedure.

USEPA, 1995, SOP 1704, Rev. 0.0, Summa Canister Sampling.

USEPA, 1996, SOP 2042, Rev. 0.0, Soil Gas Sampling

USEPA, 1999, Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected In Specially-Prepared Canisters and Analyzed By Gas Chromatography/Mass Spectrometry GC/MS) in *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, 2nd Ed., EPA Publication 625/R-96/010b.

USEPA, 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

STANDARD OPERATING PROCEDURE NO. SAS-11-03

INSTALLATION OF PROBES/WELLS FOR SVE SYSTEM EFFECTIVENESS AND VAPOR MIGRATION MONITORING Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the installation of semi-permanent to permanent soil vapor monitoring probes/wells for the evaluation of Soil Vapor Extraction (SVE) system effectiveness and subsurface vapor migration. This SOP also describes selection, including advantages and disadvantages, of drilling methods, probe/well materials and construction/configuration.

2.0 EQUIPMENT AND MATERIALS

- Drilling equipment and supplies (Drilling method specific);
- Well casing and screen materials (See Sections 4.3 & 4.4 below);
- Filter pack sand;
- Bentonite;
- Grout (optional);
- Portland cement;
- Asphalt (as necessary for surface restoration);
- Stick-up or flush-mount protective well covers;
- 4-way micro-valve (Probe/well less than 1 inch in diameter);
- Zip ties (Probe/well less than 1 inch in diameter);
- ¼-inch outside diameter (O.D.) silicone, Tygon, or Teflon tubing (Probe/well less than 1 inch in diameter);

- Expandable well cap retrofitted with a with a 1/8-Inch, NPT, chrome-plated brass, non-valved, coupling insert (herein referred to as "coupling insert") and vinyl slip cap (Probe/wells 1 inch or more in diameter);
- Metal well ID tag (optional);
- Probe/well location maps;
- Miscellaneous tools;
- Chain of custody forms and seals; and
- Field logbook and/or appropriate field form.

Coupling Insert

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

Underground utilities, whether private, commercial, or public, shall be cleared in accordance with SOP ENV-05-01 prior to commencing drilling activities.

4.0 PROBE/WELL INSTALLATION

4.1 Considerations

Prior to the selection of drilling method(s), materials and diameters, screen length(s), and configuration, and installation of probes/wells, several key factors must be considered.

4.1.1 Project Objectives and Costs

Short- and long-term objectives shall be defined in the early stages of the project with respect to the type of data required, purpose, and mean(s) of evaluating the data. The project objectives shall define whether probes/wells shall be utilized for purposes other than SVE system effectiveness and vapor migration monitoring. While multiple purpose probes/wells can reduce drilling costs, effects on data quality shall be evaluated with respect to project objectives.

4.1.2 Site Conditions and Access

Site conditions and access shall also be considered to prevent project delays, increased project costs, and deviations from project objectives.

4.1.3 Surface and Subsurface Geological and Hydrologic Conditions

Geologic and hydrologic conditions are critical factors in the selection of drilling method(s), materials and diameters, screen length(s), and configuration, and installation of probes/wells. To the extent practical, surface and subsurface geologic and hydrologic conditions shall be characterized prior to probe/well material and construction/configuration selection and installation. Soil materials, variability within stratigraphic units, preferential pathways, confined/unconfined conditions, actual or potential perched water conditions, water table elevation and variability, and presence of constituents of concern or free phase product shall be considered prior to selection of probe/well material, diameter, screen length and configuration. If geologic and hydrologic conditions cannot be characterized prior to probe/well installation, anticipated conditions shall be discussed with the field staff prior to the commencement of field activities.

4.2 Drilling Method Selection

Common drilling methods include auger, rotary, and direct push technologies. Both hollow-stem and solid-stem auger methods can be used in unconsolidated soils and semi-consolidated (e.g. weathered rock) soils, but not in competent rock. Each method can be employed without introducing foreign materials (e.g. drilling fluids, etc.) into the borehole, thus minimizing the potential for cross contamination. This method consists of a drill pipe or drill stem coupled to a drilling bit that rotates and cuts through soils and competent rock. The

cuttings produced from the rotation of the drilling bit are transported to the surface by drilling fluids (e.g. water, drilling mud, or air) in all cases except for sonic rotary. Sonic rotary methods do not require the addition of any fluids in unconsolidated material because the vibration of the sonic rotary head allows the drill bit to cut without fluids. Consolidated materials may require some water to cool the drill bit. Direct push technology (DPT) use a hydraulic system to advance a 2- or 4-foot stainless steel sampler with a liner, typically acetate, attached to small-diameter, hollow drill rods into the subsurface. The sampler can be configured to allow for discrete interval sampling. Since the sampler is advanced hydraulically, soil cuttings generated by this method are minimal. DPT can be employed without introducing foreign materials (e.g. drilling fluids, etc.) into the borehole and in locations not accessible to most drill rigs. This method can be used in most unconsolidated soils, but not depositions consisting primarily of coarse gravel, cobbles, and/or weathered bedrock. Boreholes can be augured to depths of 40 feet or more (depending on the Geoprobe™ size and stratigraphy), but generally boreholes are advanced to depths of less than 30 feet. Due to the borehole diameter, probe/well installation is limited to small-diameter materials.

In general, air, water, and mud rotary drilling methods shall not be selected for probe/well installation since they introduce foreign materials into the borehole that have the potential to alter or inhibit vapor migration in the immediate vicinity of the probe/well and inhibit vapor migration into the probe/well screen. Table 1 (see Attachment A) shall be used as a guide in selecting drilling method(s).

4.3 Selection of Probe/Well Material and Diameter

Material and diameter selection shall be primarily based on well purpose (single or multiple uses), geologic and hydrologic conditions, and the anticipated probe/well construction/configuration. In general, well diameters greater than four inches, regardless of material, shall be deemed unsuitable due to the volume of air required to purge prior to sample collection. Table 2 (see Attachment B) shall be used as a guide in selecting probe/well materials and diameters.

4.4 Probe/Well Screen Length Selection

Screen length selection shall be based on probe/well purpose (single or multiple uses), geologic and hydrologic conditions, and type of data desired (discrete or composite). Single use probes/wells, those dedicated to SVE system effectiveness and vapor migration monitoring, generally offer more flexibility in screen length selection. Multiple use probes/wells generally offer less flexibility in screen length selection and typically require longer screen lengths to fulfill its various functions. Geologic and hydrologic conditions (e.g. zones of increased permeability/preferential contamination migration or groundwater pathways within a stratigraphic unit, variability in groundwater elevation, etc.) combined with the type of data desired strongly influence screen length selection.

Shorter screen lengths, generally one half to two feet in length, shall be preferred for the monitoring of zones of increased permeability/preferential pathways or discrete intervals with a stratigraphic unit, or the entire thickness of a thinner layer of soil material. Shorter screen lengths are generally preferred for single use probes/wells because they minimize 1) the potential to screen more than one stratigraphic unit or preferential pathway and 2) purge volumes required prior to sampling.

Medium screen lengths, generally two to ten feet in length, shall be preferred for the monitoring of the entire thickness of a stratigraphic unit or stratigraphic units prone to perched water and/or relatively moderate to high fluctuations in groundwater elevation. Medium screen lengths are generally preferred for multi-use probes/wells because they minimize the potential to screen more than one stratigraphic unit.

Long screen lengths, general ten feet or more in length, shall be preferred for multi-use probes/wells intended for regular groundwater and/or product monitoring and/or sampling, especially when relatively moderate to high fluctuations in groundwater elevation are anticipate. In general, probes/wells with screen lengths fifteen feet or longer shall not be deemed adequate for SVE system effectiveness and vapor migration monitoring because they 1) increase the potential to screen more than stratigraphic unit, 2) may not allow for the collection of a sample representative of the entire screened interval, and 3) require a larger purge volume prior to soil vapor sample collection.

4.5 Probe/Well Configuration Selection

The vertical and horizontal configuration of probes/wells shall be a function of their intended purpose(s). Probes/wells intended to evaluate vapor migration across a plane/boundary or within area may be installed within the anticipated radius of influence (ROI) of one or more soil vapor extraction wells. Probes/wells intended to evaluate the actual ROI of a soil vapor extraction well shall be, to the extent possible, installed within the anticipated ROI of only the soil vapor extraction well to be evaluated. In both cases, probes/wells shall generally be installed at set horizontal distances from soil vapor extraction well(s) (e.g. distances equivalent to ½, ¾, and/or the anticipated ROI). Single probes/wells, nested probes/wells, or a combination thereof shall be utilized to achieve project and data quality objectives. Single probes/wells are utilized to monitor one stratigraphic unit or one zone of increased permeability/preferential contamination migration or groundwater pathways within a stratigraphic unit. Nested probes/wells are utilized to monitor multiple stratigraphic units or zones of increased permeability/preferential contamination migration or groundwater pathways within a stratigraphic unit.

4.6 Execution

4.6.1 General

Probes/wells intended for SVE system effectiveness and vapor migration monitoring shall be installed in a manner similar to the installation of wells intended for groundwater monitoring/sampling with the following exceptions:

1. Water shall not be utilized to settle the filter pack (especially in confined stratigraphic units);
2. Bentonite grout shall generally be preferred over placing and then hydrating bentonite pellets/chips;
3. Probe/well screens and associated filter pack shall not, to the extent possible, extend into more than one stratigraphic unit;
4. Probe/well screens and associated filter pack shall not, to the extent possible, extend into more than one confining unit (e.g. clay layer);
5. To the extent possible, a minimum of five (5) feet of bentonite should be placed between the screens and filter packs of individual probes/wells that have been nested within the same borehole to prevent short-circuiting between probes/wells;

6. Probes/wells installed within or adjacent to utility corridors or building foundations shall be protected, to the extent possible, against short-circuiting with the ground surface.
7. Probes/wells installed with screens and/or filter pack within five (5) feet of ground surface shall be protected with impermeable materials (e.g. geotextile, plastic blankets, etc), to the extent possible, against short-circuiting with the ground surface; and
8. Probes/wells shall generally be installed using hollow-stem auger, sonic rotary, or direct push technology methods, unless otherwise required by the Site-Specific Work Plan or the Engineer of Record for the SVE System.

4.6.2 SVE System Effectiveness Monitoring

Probes/wells intended for SVE system effectiveness monitoring shall undergo pre-system start up (a.k.a. baseline) monitoring following the procedures described SOP ENV-11-03 to 1) establish a representative set of baseline data and 2) facilitate a defensible evaluation of post-system start up data set.

5.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2001, ASTM Standard D 5314-92 (2001) Standard Guide for Soil Gas Monitoring in the Vadose Zone.

USEPA, 1994, SOP # 1703, Rev #: 0.0, Summa Canister Cleaning Procedure.

USEPA, 1995, SOP #1704, Rev. #: 0.0, Summa Canister Sampling.

USEPA, 1996, SOP # 2042, Rev. #: 0.0, Soil Gas Sampling

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USEPA, 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

ATTACHMENT A
TABLE 1 – DRILLING METHOD SELECTION

TABLE 1
Drilling Method Selection

SOP SAS-11-03 - ATTACHMENT A

DRILLING METHOD	ADVANTAGES	DISADVANTAGES	NOTES
Hollow-Stem Auger	● Can be used in unconsolidated and semi-consolidated soils ● No Introduction of foreign materials into the borehole ● Suited for soils that tend to collapse ● Probe/well can be installed inside the auger ● Can facilitate the installation of larger diameter probes/wells ● Can facilitate the installation of more than one small diameter probe/well in a single borehole ● Boreholes can be drilled to depths of 100 feet or more	● Cannot be used in competent rock ● Retracting augers in caving sand conditions can be extremely difficult ● Generates large amounts of soil cuttings	● Generally deemed suitable for the installation of probes/wells, intended for SVE system effectiveness and vapor migration monitoring, in unconsolidated and semi-consolidated soils ● Preferred drilling method for the installation of probes/wells with a diameter equal to or greater than one inch and/or nested probes/wells in a single borehole in unconsolidated and semi-consolidated soils
Solid-Stem Auger	● Can be used in unconsolidated and semi-consolidated soils ● No Introduction of foreign materials into the borehole ● Can facilitate the installation of larger diameter probes/wells ● Can facilitate the installation of more than one small diameter probe/well in a single borehole ● Boreholes can be drilled to depths of 150 feet or more	● Cannot be used in competent rock ● Not suited for soils that tend to collapse ● Generates large amounts of soil cuttings	● Generally deemed suitable for the installation of probes/wells, intended for SVE system effectiveness and vapor migration monitoring, in unconsolidated and semi-consolidated soils

TABLE 1
Drilling Method Selection

SOP SAS-11-03 - ATTACHMENT A

DRILLING METHOD	ADVANTAGES	DISADVANTAGES	NOTES
Air Rotary	● Can be used in unconsolidated and semi-consolidated soils and rock ● Can facilitate the installation of larger diameter probes/wells ● Can facilitate the installation of more than one small diameter probe/well in a single borehole ● Boreholes can be drilled to depths of 150 feet or more	● Introduces foreign materials into the borehole ● Generates large amounts of soil cuttings ● Conventional method does not control the blowing of cuttings out of the borehole	● Generally deemed unsuitable for the installation of probes/wells intended for SVE system effectiveness and vapor migration monitoring
Water Rotary	● Can be used in unconsolidated and semi-consolidated soils and rock ● Can facilitate the installation of larger diameter probes/wells ● Can facilitate the installation of more than one small diameter probe/well in a single borehole ● Boreholes can be drilled to depths of 150 feet or more	● Introduces foreign materials into the borehole ● Generates large amounts of soil cuttings ● Drilling fluids can carry contamination from a contaminated zone to an uncontaminated zone	● Generally deemed unsuitable for the installation of probes/wells intended for SVE system effectiveness and vapor migration monitoring
Mud Rotary	● Can be used in unconsolidated and semi-consolidated soils and rock ● Can facilitate the installation of larger diameter probes/wells ● Can facilitate the installation of more than one small diameter probe/well in a single borehole ● Boreholes can be drilled to depths of 150 feet or more	● Introduces foreign materials into the borehole ● Generates large amounts of soil cuttings ● Drilling fluids can carry contamination from a contaminated zone to an uncontaminated zone	● Generally deemed unsuitable for the installation of probes/wells intended for SVE system effectiveness and vapor migration monitoring

TABLE 1
Drilling Method Selection

SOP SAS-11-03 - ATTACHMENT A

DRILLING METHOD	ADVANTAGES	DISADVANTAGES	NOTES
Sonic Rotary	● Can be used in unconsolidated and semi-consolidated soils and rock ● Minimal smearing of formation materials ● Can facilitate the installation of larger diameter probes/wells ● Can facilitate the installation of more than one small diameter probe/well in a single borehole ● Boreholes can be drilled to depths of 150 feet or more	● Requires large open spaces for rig and support equipment ● Expensive compared to other methods ● In flowing sands, introduction of a foreign materials (potable water) is required	● Generally deemed suitable for the installation of probes/wells intended for SVE system effectiveness and vapor migration monitoring ● Preferred drilling method for the installation of probes/wells with a diameter equal to or greater than one inch and/or nested probes/wells in a single borehole in competent rock
Direct Push Technologies	● Can be used in unconsolidated and semi-consolidated soils and rock ● No Introduction of foreign materials into the borehole ● Can access locations not accessible by other drilling equipment ● Generates minimal amounts of soil cuttings	● Cannot be used in depositions consisting of coarse gravel, cobbles, and/or weathered or competent rock ● Cannot facilitate the installation of larger diameter probes/wells ● Cannot facilitate the installation of more than one small diameter probe/well in a single borehole ● Drilling depth is limited compared to other drilling methods	● Generally deemed suitable for the installation of small-diameter probes/wells intended for SVE system effectiveness and vapor migration monitoring ● Preferred drilling method for the installation of probes/wells with a diameter less than one inch in unconsolidated and semi-consolidated soils
Hand Auger	● Can be used in unconsolidated soils ● No Introduction of foreign materials into the borehole ● Can access locations not accessible by other drilling equipment ● Generates minimal amounts of soil cuttings	● Cannot be used in depositions consisting of coarse gravel, cobbles, and/or weathered or competent rock ● Cannot facilitate the installation of larger diameter probes/wells ● Cannot facilitate the installation of more than one small diameter probe/well in a single borehole ● Drilling depth is limited compared to other drilling methods	● Generally deemed suitable for the installation of shallow, small-diameter probes/wells intended for SVE system effectiveness and vapor migration monitoring, but is not the preferred drilling method

ATTACHMENT B
TABLE 2 – PROBE/WELL MATERIAL AND DIAMETER SELECTION

TABLE 2
Probe/Well Material and Diameter Selection

SOP SAS-11-03 - ATTACHMENT B

WELL MATERIAL	WELL DIAMETER	ADVANTAGES	DISADVANTAGES	NOTES
Polyvinyl Chloride (PVC)	1-Inch I.D.	● Suitable for single probe/well construction in small to large diameter boreholes ● Suitable for nested probes/wells in medium to large diameter boreholes ● Relatively low purge volume per foot of casing/screen ● Can be fitted with various screen lengths (1, 5, and 10 foot screens) ● Allows for fluid level gauging to confirm well screen masking by fluids ● Limited suitability for other purposes (e.g. groundwater/product gauging and sampling) ● Relatively inexpensive material	● Unsuitable for nested probes/wells in small diameter boreholes ● Limited suitability for other purposes	● Generally deemed suitable for the installation of single or nested probes/wells, intended for SVE system effectiveness and vapor migration monitoring, in unconsolidated and semi-consolidate soils and competent rock. ● Preferred material and diameter for monitoring within most depositional environments including fine grained materials, confined conditions, and the caprillary fringe
Polyvinyl Chloride (PVC)	2-Inch I.D.	● Suitable for single probe/well construction in large diameter boreholes ● Can be fitted with various screen lengths (1, 5, and 10 foot screens) ● Allows for fluid level gauging to confirm well screen masking by fluids ● Suitable for other purposes (e.g. groundwater/product gauging and sampling) ● Relatively inexpensive material	● Limited suitability for single probe/well construction in small and medium diameter boreholes ● Generally, unsuitable for nested probes/wells ● Relatively moderate purge volume per foot of casing/screen	● Generally deemed suitable for the installation of single or nested probes/wells, intended for SVE system effectiveness and vapor migration monitoring, in unconsolidated and semi-consolidate soils and competent rock. ● Preferred material and diameter for probes/wells intended for multiple uses in most depositional environments

TABLE 2
Probe/Well Material and Diameter Selection

SOP SAS-11-03 - ATTACHMENT B

WELL MATERIAL	WELL DIAMETER	ADVANTAGES	DISADVANTAGES	NOTES
Polyvinyl Chloride (PVC)	4-Inch I.D.	● Suitable for single probe/well construction in large diameter boreholes ● Can be fitted with various screen lengths (5, and 10 foot screens) ● Allows for fluid level gauging to confirm well screen masking by fluids ● Suitable for other purposes (e.g. groundwater/product gauging and sampling) ● Relatively inexpensive material	● Unsuitable for nested probes/wells ● Relatively high purge volume per foot of casing/screen	● Generally deemed unsuitable for SVE system effectiveness and vapor migration monitoring due to the high purge volume per foot of casing/ screen ● Limited suitability for vacuum/ pressure gauging
Stainless Steel	1/8-Inch O.D.	● Suitable for single probe/well construction in small to large diameter boreholes ● Suitable for nested probe/well construction in small to large diameter boreholes ● Minimal purge volume per foot of casing/screen	● Does not allow for fluid level gauging to confirm well screen masking by fluids ● Generally limited to a 0.5-foot well screen ● Extremely difficult to rehabilitate the well, when necessary ● Unsuitable for other purposes	● Generally deemed suitable for the installation of single or nested probes/wells, intended for SVE system effectiveness and vapor migration monitoring, in unconsolidated and semi-consolidate soils and competent rock. ● Preferred material and diameter for monitoring within depositional environments characterized by fine-grained materials and unconfined conditions well above the water table

TABLE 2
Probe/Well Material and Diameter Selection

SOP SAS-11-03 - ATTACHMENT B

WELL MATERIAL	WELL DIAMETER	ADVANTAGES	DISADVANTAGES	NOTES
Stainless Steel	1/4-Inch O.D.	● Suitable for single probe/well construction in small to large diameter boreholes ● Suitable for nested probe/well construction in small to large diameter boreholes ● Minimal purge volume per foot of casing/screen	● Does not allow for fluid level gauging to confirm well screen masking by fluids ● Generally limited to a 0.5-foot well screen ● Extremely difficult to rehabilitate the well, when necessary ● Unsuitable for other purposes	● Generally deemed suitable for the installation of single or nested probes/wells, intended for SVE system effectiveness and vapor migration monitoring, in unconsolidated and semi-consolidate soils and competent rock. ● Preferred material and diameter for monitoring within depositional environments characterized by fine-grained materials and unconfined conditions well above the water table
Stainless Steel	2-Inch I.D.	● Suitable for single probe/well construction in medium to large diameter boreholes ● Can be fitted with various screen lengths (1, 5, and 10 foot screens) ● Allows for fluid level gauging to confirm well screen masking by fluids ● Suitable for other purposes (e.g. groundwater/product gauging and sampling)	● Limited suitability for single probe/well construction in small diameter boreholes ● Generally, unsuitable for nested probes/wells ● Relatively moderate purge volume per foot of casing/screen ● Relatively expensive material	● Generally deemed suitable for the installation of single or nested probes/wells, intended for SVE system effectiveness and vapor migration monitoring, in unconsolidated and semi-consolidate soils and competent rock. ● Preferred diameter for probes/wells intended for multiple uses in most depositional environments

TABLE 2
Probe/Well Material and Diameter Selection

SOP SAS-11-03 - ATTACHMENT B

WELL MATERIAL	WELL DIAMETER	ADVANTAGES	DISADVANTAGES	NOTES
Stainless Steel	4-Inch I.D.	● Suitable for single probe/well construction in large diameter boreholes ● Can be fitted with various screen lengths (5, and 10 foot screens) ● Allows for fluid level gauging to confirm well screen masking by fluids ● Suitable for other purposes (e.g. groundwater/product gauging and sampling)	● Unsuitable for nested probes/wells ● Relatively high purge volume per foot of casing/screen ● Relatively expensive material	● Generally deemed unsuitable for SVE system effectiveness and vapor migration monitoring due to the high purge volume per foot of casing/ screen ● Limited suitability for vacuum/ pressure gauging

STANDARD OPERATING PROCEDURE NO. SAS-11-04

SVE SYSTEM EFFECTIVENESS AND VAPOR MIGRATION MONITORING Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for the monitoring of semi-permanent to permanent soil vapor monitoring probes/wells for the evaluation of Soil Vapor Extraction (SVE) system effectiveness and subsurface vapor migration. This SOP also describes field measurements and soil vapor collection methods, and quality assurance procedures.

2.0 EQUIPMENT AND MATERIALS

- Digital manometer (Dwyer Series 475 Mark III Digital Manometer or equivalent) or magnehelic differential pressure gauge (0-20 inches of water);
- Digital manometer (Dwyer Series 475 Mark III Digital Manometer or equivalent)or magnehelic differential pressure gauge (0-200 inches of water);
- 1-liter Tedlar™ bags;
- Tygon™ or silicone tubing (cut to length);
- ¼-inch O.D. Teflon™, Polyethylene, or PVC tubing (cut to length);
- GeoTech Peristaltic Pump or equivalent;
- BIOS DC-LITE flow calibrator, calibrated rotometer, or equivalent;
- 60-mL syringe for purging (Probe/well less than 1 inch in diameter);
- Stainless-steel manual pump for purging (Probe/well equal to or greater than 1 inch in diameter);
- Extra vinyl slip covers;
- Clean (dedicated) 3/16-Inch hose barb, chrome-platted brass, non-valved, in-line coupling body (herein referred to as “coupling body”);
- New or dedicated 4-way valves for purging and sampling;
- Summa (or equivalent) canisters;

Coupling Body

- Sample flow controller;
- ¼-inch O.D. Teflon sample line;
- ¼-inch O.D. Teflon or stainless-steel compression fittings;
- Probe/well location maps;
- Miscellaneous tools (i.e. socket set to remove well/probe caps);
- Chain of custody forms and seals; and
- Field logbook and/or appropriate field form.

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 EXECUTION

Probes/wells intended for SVE system effectiveness monitoring shall undergo pre-system start up (a.k.a. baseline) monitoring to 1) establish a representative set of baseline data and 2) facilitate a defensible evaluation of post-system start up data set. Procedures for baseline and post-system start up monitoring are described in the following sections.

4.1 Vacuum/Pressure Gauging

In order to evaluate the degree of influence that a soil vapor extraction (SVE) wells have on surrounding area, vacuum measurements shall be collected from designated monitoring locations prior to any soil vapor sampling. The Dwyer digital manometer or magnehelic differential pressure gauge or equivalent (herein referred to as the “gauging instrument”) shall be used for this measurement. Immediately prior to use, the

gauging instrument shall be zeroed at atmospheric pressure. Vacuum/pressure measurements shall be obtained using the of the following probe/well diameter-specific procedures.

4.1.1 Probe/Well Diameters Less Than One Inch

At probes/wells with a diameter of less than one-inch, the positive fitting on the gauging instrument shall be connected to the 4-way valve, previously installed to the top of the well riser, using small diameter silicone tubing of appropriate size. The negative fitting on the gauging instrument shall remain open to the atmosphere. The 4-way valve shall be opened to the well and closed to the atmosphere. The gauging instrument shall be allowed a maximum of thirty (30) minutes to stabilize before the vacuum/pressure is recorded. If the gauging instrument does not stabilize within the 30-minute period, the range in which the vacuum/pressure reading fluctuates over an additional one (1) minute period will be documented in the field logbook and/or on the appropriate field form. The highest reading observed within the observed range will be recorded in the field logbook and/or on the appropriate field form as the primary measurement. (*Please note: If the gauging instrument reading fluctuates between two vacuums, the lowest/weakest vacuum observed will be recorded as the primary measurement. If the gauging instrument reading fluctuates between a vacuum and a pressure, the highest pressure observed will be recorded as the primary measurement. If the manometer reading fluctuates between two pressures, the highest/strongest pressure observed will be recorded as the primary measurement. In all cases, the range in the gauging instrument readings over the additional one-minute period will be recorded in the field logbook and/or on the appropriate field form.)* The vacuum/pressure measurement shall be recorded to the nearest hundredth of an inch of water column in the field logbook and/or on the appropriate field form first, followed by any secondary data entry devices (i.e. PDA, laptop, etc.). Please note a field form, if used, is considered the record document. Immediately following the recording of the vacuum/pressure measurement, the 4-way valve shall be closed to the well and open to the atmosphere and the gauging instrument shall be detached from the silicone tubing and 4-way valve *(see Attachment A: Guide to the 4-Way Micro-Valve).*

A picture of a typical vacuum/pressure gauging set-up is provided below.

4.1.2 Probe/Well Diameters Equal to or Greater Than One Inch

At probes/wells with a diameter equal to or greater than one-inch, the positive fitting on the gauging instrument shall be connected to a dedicated coupling body using silicone (or equivalent) tubing. The negative fitting on the gauging instrument shall remain open to the atmosphere. The coupling body shall then be connected to the coupling insert located on the expandable well cap, which will open the well to the gauging instrument. The gauging instrument shall be allowed a maximum of thirty (30) minutes to stabilize before the vacuum/pressure is recorded. If the gauging instrument does not stabilize within the 30-minute period, the range in which the vacuum/pressure reading fluctuates over an additional one (1) minute period will be documented in the field logbook and/or on the appropriate field form. The highest reading observed within the observed range will be recorded as the primary measurement. (*Please note: If the gauging instrument reading fluctuates between two vacuums, the lowest/weakest vacuum observed will be recorded as the primary measurement. If the gauging instrument reading fluctuates between a vacuum and a pressure, the highest pressure observed will be recorded as the primary measurement. If the manometer reading fluctuates between two pressures, the highest/strongest pressure observed will be recorded as the primary measurement. In all cases, the range in the gauging instrument readings over the additional one-minute period will be recorded in the field logbook and/or on the appropriate field form.)* The vacuum/pressure measurement shall be recorded to the nearest hundredth of an inch of water column in the field logbook and/or on the appropriate field form first, followed by any secondary data entry devices (i.e. PDA, laptop, etc.). Please note a field form, if used, is considered the record document. Immediately following the

recording of the vacuum/pressure measurement, the coupling body shall be disconnected from the coupling insert, which will close the well to the gauging instrument and the atmosphere. The gauging instrument and associated tubing shall then be detached from the dedicated coupling body.

4.2 Probe/Well Purging

Upon completion of any vacuum / pressure measurements and prior to soil vapor sample collection, each probe/well shall be purged a predetermined volume (in Liters or milliliters) based on the volume of the probe/well riser and screen. The purge volume shall be equivalent to a minimum of three probe/well volumes. The actual purge volume removed shall be recorded in the field logbook and/or on the appropriate field form. If the probe/well would not yield the full purge volume or water and/or product are encountered during purging, this observation shall be documented in the field logbook and/or on the appropriate field form.

4.2.1 Probe/Well Diameters Less Than One Inch

To purge the monitoring locations with a diameter less than one-inch, a 60-ml plastic syringe shall be attached to the 4-way valve, previously installed to the top of the well riser and the valve shall be configured (opened to the well and closed to the atmosphere) to allow the removal of the required purge volume. The syringe plunger shall be drawn back to evacuate a purge volume. The valve gate shall then be configured (closed to the well and opened to the atmosphere) and the syringe plunger shall be pushed in allowing the purged volume to be expelled to atmosphere. This process shall continue until a minimum of three probe/well volumes have been removed from the monitoring location. Care shall be taken to prevent the purged air from being reintroduced into the probe/well. At the completion of purging, the 4-way valve shall remain attached to the monitoring location with the valve configured so that the well is closed to atmosphere. Failure to close the 4-way valve to atmosphere prior to attaching the Tedlar™ bag or Summa canister will result in a volume of ambient air infiltrating back into the well riser and subsequently being collected as a sample *(see Attachment A: Guide to the 4-Way Micro-Valve)*.

4.2.2 Probe/Well Diameters Equal to or Greater Than One Inch

Purging probes/wells with diameters equal to or greater than one inch requires the use of a stainless steel hand pump in conjunction with silicone (or equivalent) tubing and a dedicated coupling body. The hand pump shall be tested prior to each sampling event by attaching a 1-liter Tedlar™ test bag to the hand pump outlet. The inlet of the hand pump shall remain open to atmosphere. Two strokes of a properly working hand pump should fill a 1-liter bag to approximately 75-percent of capacity. The 1-liter bag should not be completely filled because the bags are typically oversized in order to allow for expansion of the sample during shipment, storage, etc. The hand pump shall be rebuilt in accordance with manufacturer specifications if the hand pump fails to adequately fill the test bag.

The stainless steel hand pump shall be used in conjunction with silicone (or equivalent) tubing and a dedicated coupling body. The vacuum side of the hand pump shall be attached to a dedicated coupling body using silicone (or equivalent) tubing. The dedicated coupling body shall then be connected to the coupling insert located on the expandable well cap, which will allow for the removal of purge volumes from the probe/well. The hand pump has an internal one-way valve and, therefore, manipulation of the coupling body and coupling insert shall not be necessary. The purged volume is expelled to atmosphere from the positive side of the hand pump with every downward stroke of the pump handle (piston). Every upward stroke of the pump handle should remove approximately ½-liter of the purge volume from the well. Care shall be taken to fully extend the hand pump handle to ensure that the appropriate volume is removed from the probe/well with each pump stroke. When a minimum of three well volumes have been removed from the monitoring location, the coupling body shall be disconnected from the coupling insert, which closes the probe/well to atmosphere.

4.3 Soil Vapor Sample Collection

Upon completion of probe/well purging (evacuation of a minimum of three probe/well volumes of air), soil vapor sample collection using Tedlar™ sample media and/or summa (or equivalent) canisters shall commence. If water and/or product are encountered during sample collection, this observation shall be documented in the field logbook and/or on the appropriate field form.

4.3.1 Tedlar™ Bag Sample Media

Soil vapor samples for on-site analysis/field screening shall be collected using a Tedlar™ bag media and a peristaltic pump. For probes/wells with a diameter less than one-inch, the peristaltic pump shall be attached to a 4-way plastic micro valve using a combination of Tygon™ and silicone (or their respective equivalent) tubing. The valve, which was used for the well purging, should already be attached to the top of the well riser. For probes/wells with a diameter greater than or equal to one-inch, the peristaltic pump shall be attached to the dedicated coupling body using a combination of Tygon™ and silicone (or their respective equivalent) tubing. The outlet of the peristaltic pump shall be attached to the inlet side of the flow calibrator (or rotometer) using a combination of Tygon™ and silicone (or their respective equivalent) tubing. Prior to flow rate adjustment and sample collection, the sample identification, date, time, and vacuum/pressure reading (if applicable) shall be clearly documented on the Tedlar™ Bag.

4.3.1.1 Flow Rate Adjustment

The flow calibrator or calibrated rotometer shall be used to adjust the flow rate of the peristaltic pump to allow a flow rate of less than 200 mL/minute. For probes/wells with a diameter less than one-inch, this adjustment shall be performed by 1) configuring the micro valve to allow for sample removal from the well, 2) depressing the read button on the flow meter and noting the rate of sample flow or if a calibrated rotometer is used, simply observe the flow rate indicated by the ball height, and 3) quickly adjusting the peristaltic pump to allow a flow rate of 200-ml/minute or less. For probes/wells with a diameter greater than or equal to one-inch, this adjustment shall be performed by 1) connecting the coupling body to the coupling insert to allow for sample removal from the well, 2) depressing the read button on the flow meter and noting the rate of sample flow or if a calibrated rotometer is used, simply observe the flow rate indicated by the ball height, and 3) quickly adjusting the peristaltic pump to allow a flow rate of 200-ml/minute or less. *Notes: The initial settings on the pump should be set to allow for the minimum flow possible. It is important to set the flow rate as quickly as possible in order to minimize the amount of additional sample volume. An advantage that the use of a rotometer has over a flow meter is that an instantaneous flow reading will be displayed, allowing for a much quicker flow-rate adjustment to the peristaltic pump.* After setting the sample flow, sample collection shall be immediately initiated. Care shall be taken at this time to avoid unintentionally adjusting (by bumping or handling) the pump speed control.

4.3.1.2 Sample Collection

After setting the sample flow, the flow calibrator or calibrated rotometer shall be removed from the sample train and a new, clean, pre-labeled, one-liter Tedlar™ bag shall be connected to the tubing exiting from the positive-pressure (output) side of the peristaltic pump. A wire tie shall be used, if necessary, to make the connection between the bag and the pump a leak proof fitting. Immediately open the valve on the Tedlar™ bag approximately one turn. *Please note: Unless a vacuum/pressure reading was not collected, the sample time is the same time as the acquisition of the primary vacuum/pressure measurement. If a vacuum/pressure measurement was not collected, the sample-start time shall be documented in the field logbook and/or on the appropriate field form.* Based on the flow rate to collect a 1-liter vapor sample, the peristaltic pump shall be allowed approximately five (5) minutes to collect the sample. Total sample collection time, which may exceed five (5) minutes, is dependent on the soil characteristics of the stratigraphic unit (a.k.a. stratum) from which the sample is being collected. Upon retrieval of the one-liter sample volume, the valve on the Tedlar™ bag shall be closed and the peristaltic pump turned off. The micro valve shall then be configured such that the valve is closed to the well and open to the atmosphere (well diameters less than one-inch) or the coupling body shall be disconnected from the coupling insert (well diameters greater than or equal to one-inch). The sample bag shall be placed in a black trash bag or container that will not allow sunlight to pass through.

Duplicate samples shall be collected by repeating the preceding procedure detailed above. The duplicate sample shall be collected immediately after the first sample (original/main sample) has been collected. Due to the nature of the coarse-adjustment valves that are typically installed on Tedlar™ bags, the use of a sample splitter is not recommended since this will often result in the collection of unequal sample volumes.

4.3.1.3 Post-Sample Collection

The sample train shall be dismantled and all non-dedicated lines used for sample collection shall be disposed of. New sample lines at each sample location shall be used, except for dedicated equipment (4-way micro valves, fittings, and coupling bodies, etc.). The micro valve shall remain attached to probes/wells with a well diameter less than one-inch, however; the valve shall be configured so that the probe/well is closed to atmosphere *(see Attachment A: Guide to the 4-Way Micro-Valve)*. For probes/wells with a diameter equal to

or greater than one inch, the vinyl slip cover shall be fitted over the coupling insert on the expandable well cap following sampling collection. The dedicated equipment (coupling body) used for the monitoring locations with a probe/well diameter equal to or greater than one-inch shall be placed into a labeled, re-sealable bag. Non-dedicated, reusable equipment shall be cleaned / decontaminated in accordance with SOP ENV-04-04 or as otherwise required by the Site-Specific Work Plan.

4.3.2 Summa™ Canister Sample Media

Soil vapor samples for commercial laboratory analysis shall be obtained using Summa™ or equivalent canisters. For probes/wells with a diameter less than one-inch, the Summa (or equivalent) canister shall be attached directly to a 4-way plastic micro valve using silicone tubing. The valve, which was used for the well purging, should already be attached to the top of the well riser. For probes/wells with a diameter greater than or equal one-inch, the Summa™ (or equivalent) canister shall be attached directly to the dedicated coupling body located on the expandable well cap using silicone tubing.

4.3.2.1 Canister Preparation and QA/QC

A Summa canister is a stainless steel container which has had its internal surfaces passivated using the "Summa" process. The process uses an electro polishing step in conjunction with chemical deactivation. The overall process results in a chemically inert interior surface of the media which allows for the collection and subsequent analysis of samples containing very low concentrations of VOCs. The Summa media is available in a number of different sizes. Typically, 6-liter Summa canisters are used for the collection of soil vapor samples because this volume should allow for low detection limits and facilitate more complex analyses.

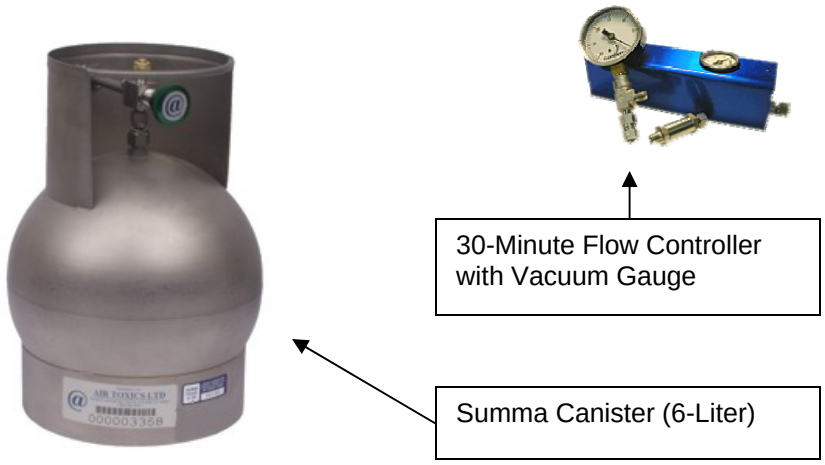
Once the laboratory cleaning process is completed, the Summa canisters are prepared by the laboratory for use in the field. Each canister is evacuated to achieve a vacuum pressure of approximately 30-inches of mercury. The pressure differential between the canister and atmosphere allows for the Summa canister to sample without the use of a separate sample pump. Depending on the project requirements, either grab or integrated samples may be collected. The holding time (shelf life) for Summa canisters that have been prepared for use in the field is 30-days. If the canister has not been used within this time-period, it shall be returned to the contracted laboratory for re-conditioning.

Summa canisters undergo either an individual or batch certification process. The individual certification process requires that each canister undergo a comprehensive Quality Assurance/Quality Control (QA/QC) procedure that results in analysis documentation for each canister, verifying that there are no residual compound concentrations above a pre-determined level. Typically, individually certified canisters are used for ambient air sampling programs that require a high level of QA/QC. Batch certified canisters undergo the same re-conditioning process as the individually certified canisters. However, only 5-percent of randomly chosen canisters are analyzed for residual constituents. If any of the selected canisters do not meet specific certification criteria, all of the canisters in that batch are required to undergo the entire cleaning and QA/QC process again. This process is repeated until all QA/QC re-conditioning criteria are met.

4.3.2.2 Sample Set Up

Field sampling staff shall complete the sample set-up of a Summa (or equivalent) canister prior to sample collection. Each six-liter (6.0 L) Summa (or equivalent) canister shall be fitted with a dedicated sample flow controller (regulator). After verification that the valve on the canister is in the "off" position, the brass cap shall be removed from the canister inlet fitting and the sample flow controller shall be attached to the canister inlet. The brass cap shall then be installed onto the inlet of the flow controller and tighten. *Note: The 30-minute sample flow controller (regulator) is a complete assembly that shall be attached directly to the canister*. The assembly shall then be leak-checked by opening the canister valve and noting the initial vacuum reading. The vacuum should indicate between 20 and 30-inches of mercury. The canister shall not be used if the starting vacuum is less than 20-inches of mercury. The vacuum may fall a very small amount (1 to 2-inches) due to the evacuation of the flow controller and then quickly stabilize. If the vacuum does not stabilize, the flow controller or associated fittings are leaking. If possible, determine the location of the leak, and repair it accordingly. Any necessary repairs shall be document in the field logbook and/or on the appropriate field form. If the leak cannot be quickly identified and repaired, the Summa canister and flow controller shall not be used.

A picture of a typical 6-liter Summa canister and a 30-minute sample flow controller are provided below.



4.3.2.3 Sample Collection

Upon completion of sample set up, soil vapor sample collection shall begin. A short length of dedicated Teflon™ tubing shall then be installed onto the top of the flow regulator with a Teflon™ Swagelok fitting or equivalent to form a leak proof connection. The Summa (or equivalent) canister shall be connected via the Teflon™ tubing and a small length of silicon tubing to the 4-way micro valve (probes/wells with a diameter less than one-inch or the dedicated coupling body (probes/wells with a diameter equal to or greater than one inch). If necessary, a wire tie shall be used on each connection where different tubing attaches to form a leak-proof seal. For probes/wells with a diameter less than one-inch, the 4-way micro valve shall then be configured to allow sample collection (valve open to the well and sample flow controller / regulator and closed to the atmosphere) and the valve on the canister opened approximately two (2) turns. For probes/wells with a diameter greater than or equal to one-inch, the coupling body shall be connected to the coupling insert located on the expandable well cap and the valve on the canister opened approximately two (2) turns. The sample start time and beginning canister vacuum (inches of mercury [Hg]) shall be recorded in the field logbook and/or on the appropriate field form. *Note: The typical initial canister vacuum is between 20 and 30 inches of Hg.*

A picture of a typical 6-liter Summa canister, 30-minute sample flow controller, and sample train is provided below for a probe/well with a diameter less than one-inch.

When the sampler has identified a minimum change/decrease of 15 inches of Hg in canister vacuum (Initial Vacuum – Final Vacuum) and the final canister vacuum is equal to or below five (5) inches of Hg, but above two (2) inches of Hg, the valve to the canister shall be closed. For probes/wells with a diameter less than one inch, the 4-way micro valve shall then be configured to be closed to the probe/well, sample flow controller / regulator, and the atmosphere. For probes/wells with a diameter equal to or greater than one inch, the coupling body shall be disconnected from the coupling insert. *NOTE: Based on the approximate flow rate (200 milliliters per minute [mL/min], approximately thirty (30) minutes is required to collect the specified sample volume.* The sample time, canister number, and sample flow controller / regulator number shall be recorded on the chain of custody and the final canister vacuum and sample end time recorded in the field logbook and/or on the appropriate field form. The sample flow controller / regulator shall be removed from the canister and the Teflon™ sample tubing shall be discarded after a single use to prevent cross-contamination between samples. Finally, the brass cap (used earlier) shall be attached to the inlet fitting on the Summa canister and a sample identification tag/label attached to the canister.

Duplicate samples shall be collected by repeating the procedure detailed above, with the addition of a "T" splitter, and one canister attached to each end of the "T" Swagelok (compression) or equivalent fitting.

A picture of a typical set-up for the collection of a duplicate sample at a probe/well with a diameter of less than one-inch is provided below.

4.3.2.4 Post-Sample Collection

The sample train shall be dismantled and all non-dedicated lines used for sample collection shall be disposed of. New sample lines at each sample location shall be used, except for dedicated equipment (4-way micro valves, fittings, and coupling bodies, etc.). The micro valve shall remain attached to probes/wells with a well diameter less than one-inch, however; the valve shall be configured so that the probe/well is closed to atmosphere *(see Attachment A: Guide to the 4-Way Micro-Valve)*. For probes/wells with a diameter equal to or greater than one inch, the vinyl slip cover shall be fitted over the coupling insert on the expandable well cap following sampling collection. The dedicated equipment (coupling body) used for the monitoring locations with a probe/well diameter equal to or greater than one-inch shall be placed into a labeled, re-sealable bag. Non-dedicated, reusable equipment shall be cleaned / decontaminated in accordance with SOP ENV-04-04 or as otherwise required by the Site-Specific Work Plan.

4.4 Soil Vapor Sample Handling

Tedlar™ bag samples shall be transported to the onsite field screening location. Field screening shall be performed in accordance with the SOP ENV-11-05. The holding time for a Tedlar™ bag sample shall not exceed thirty-six (36) hours.

Summa canisters samples shall be shipped to the contracted laboratory under strict chain of custody procedures for offsite laboratory analysis. The holding time for a Summa sample shall not exceed fourteen (14) days.

5.0 Quality Assurance/Quality Control

5.1 Leak Testing

Leakage during soil vapor sampling may dilute samples with ambient air and produce results that underestimate actual site soil vapor concentrations. Leak testing can be conducted using direct and indirect methods to evaluate seal integrity. The type of leak testing, if any, shall be based on data quality objectives as specified in the Site-Specific Work Plan.

5.1.1 Direct

Seal integrity can be evaluated directly using an inert tracer gas (e.g. laboratory grade helium). Inert gas selection shall be conducted in conjunction with the laboratory. The sampler shall construct an air tent using polyethylene sheet or assemble a commercially available air tent which encompasses the top of the probe/well casing and the entire sample train. During sampling, the tracer gas shall be allowed to flow around the sample train connections and the bentonite or grout seal at the ground surface. Following sample collection, the air tent shall be dismantled. The soil vapor sample shall be analyzed for inert trace gas in addition to the other requested analysis. If the tracer gas is detected in the soil vapor sample, the seal integrity was compromised and the analytical results, which are not representative of the stratigraphic unit or zone within the stratigraphic unit, shall be considered invalid.

5.1.2 Indirect

Seal integrity can be evaluated indirectly by measuring oxygen and carbon dioxide levels in the soil vapor sample. Oxygen and carbon dioxide levels shall be compared to levels in ambient air, project-specific criteria, and/or data trend(s). If the soil vapor sample levels are comparable to ambient air and/or project-specific criteria and/or do not fit data trend(s), the sample results shall be considered suspect. If soil vapor analysis is being performed by an offsite laboratory, this data shall be qualified appropriately. If soil vapor analysis is being performed onsite (either by a mobile laboratory or as field screening), then the probe/well shall be re-sampled within 24 to 36 hours of the original sample. The duplicate and original sample results shall be compared and evaluated based on project-specific criteria and data trend(s) to determine if the seal integrity was compromised and validity of the data collected. The reasons supporting the qualification or invalidation of data shall be documented in the field logbook and/or on the appropriate field form or as otherwise required by the Site-Specific Work Plan or Quality Assurance Project Plan (QAPP).

6.0 REFERENCES AND ADDITIONAL RESOURCES

ASTM International, 2001, ASTM Standard D 5314-92 (2001) Standard Guide for Soil Gas Monitoring in the Vadose Zone.

USEPA, 1994, SOP # 1703, Rev #: 0.0, Summa Canister Cleaning Procedure.

USEPA, 1995, SOP #1704, Rev. #: 0.0, Summa Canister Sampling.

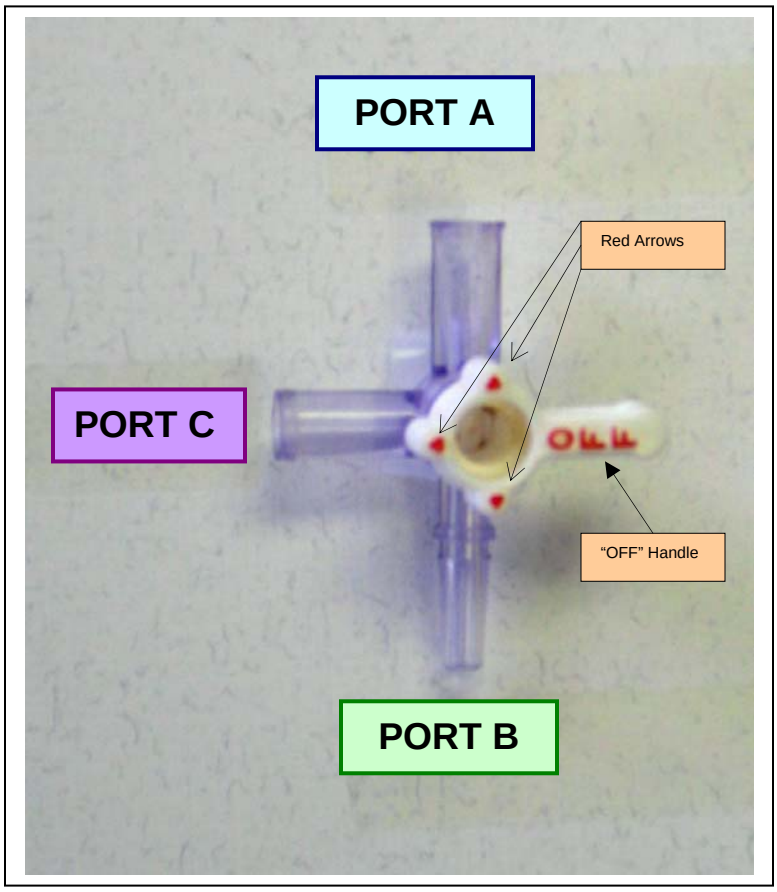
USEPA, 1996, SOP # 2042, Rev. #: 0.0, Soil Gas Sampling

USEPA, 1999, Compendium Method TO-15, Determination of Volatile Organic Compounds (VOCs) in Air Collected In Specially-Prepared Canisters and Analyzed By Gas Chromatography/Mass Spectrometry GC/MS) in *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*, 2nd Ed., EPA Publication 625/R-96/010b.

USEPA, 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

ATTACHMENT A
GUIDE TO THE 4-WAY MICRO-VALVE

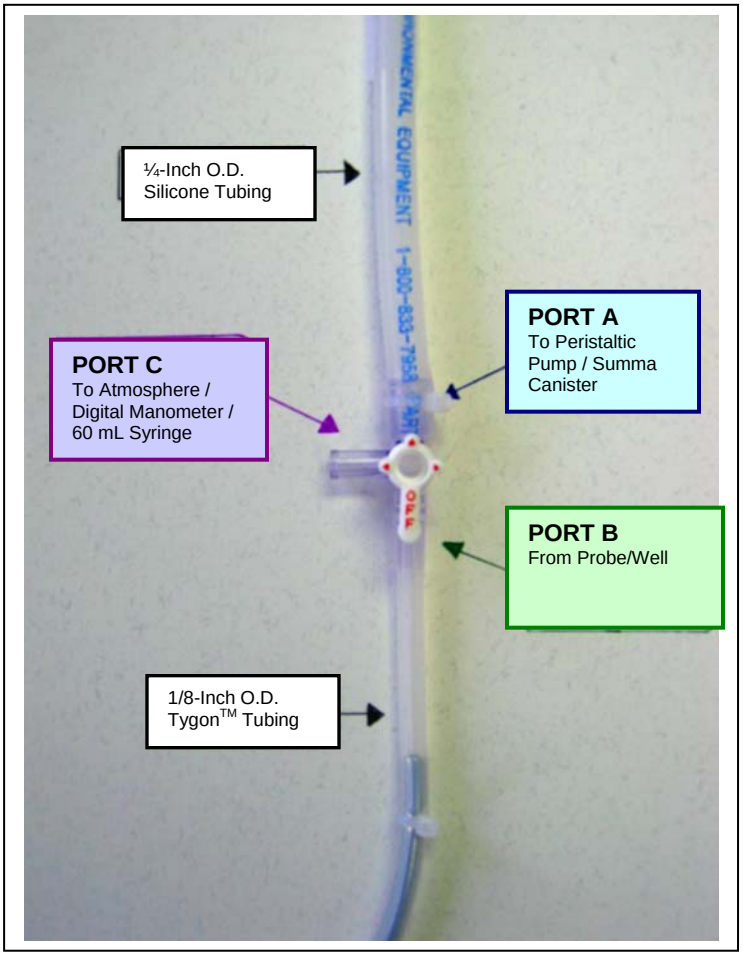
GUIDE TO THE 4-WAY MICRO-VALVE

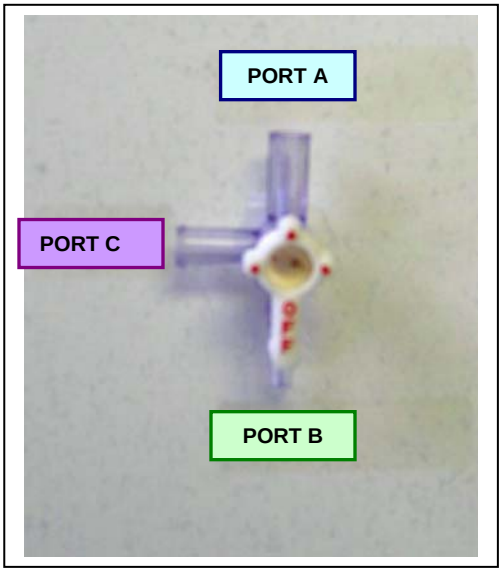


Notes:

1. Red arrows on the 4-way micro-valve indicate the ports that are currently open.
2. The "OFF" handle indicates the port that is currently closed.
3. The designation of ports is alphabetical from the top (opposite the probe/well) going in a clockwise direction.

Valve Position #1: Closed to Probe/Well





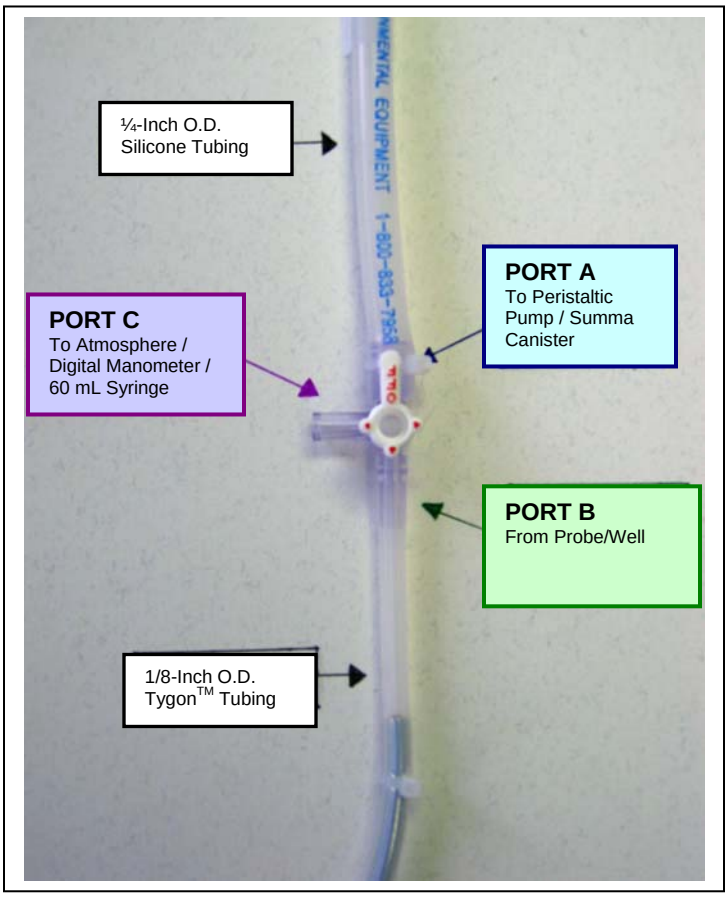
Valve Position #1:

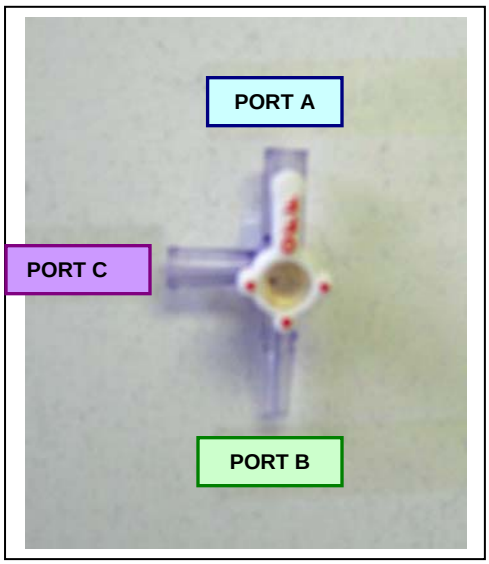
Closed to Port B (Probe/Well);
Open to Port A (Peristaltic Pump / Summa Canister)
Open to Port C (Atmosphere / Digital Manometer / 60 mL Syringe)

The "OFF" handle is turned in such a way that it is directly over Port B. The three small, red arrows opposite the "OFF" handle indicate which ports are open (Ports A & C).

In this valve position, the probe/well is not open to the atmosphere and, therefore, will not vent. If the valve is not in this position prior to the start of the monitoring (vacuum/pressure gauging, Tedlar™ bag sample collection, and/or summa canister sample collection, set the valve to Position #1 and return to this location at least 30 minutes later.

Valve Position #2: Open for Vacuum/Pressure Gauging & Purging





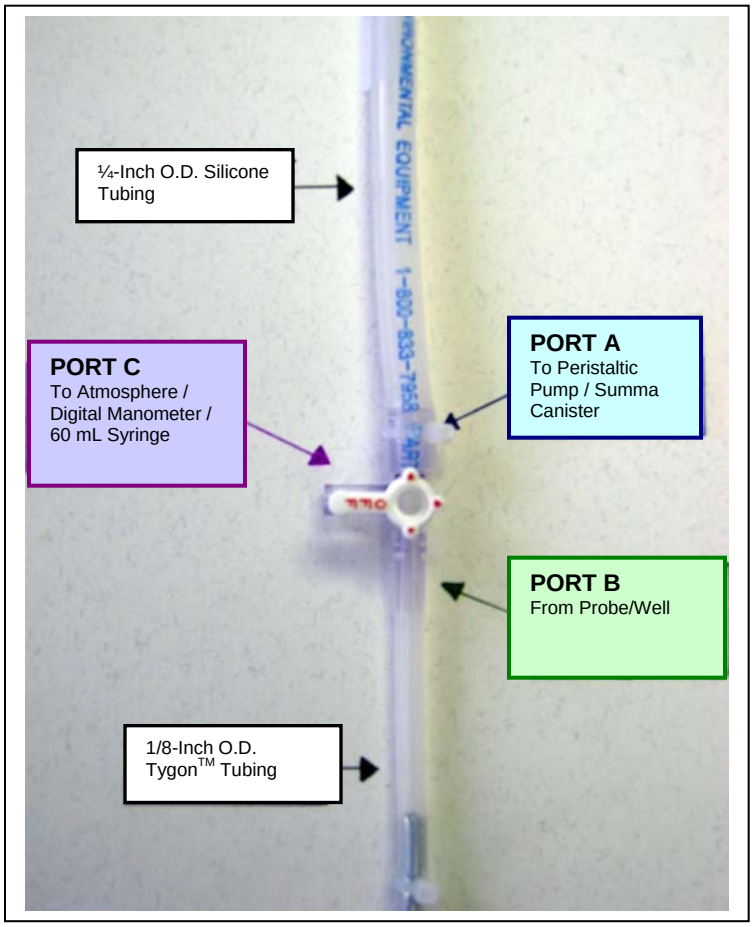
Valve Position #2:

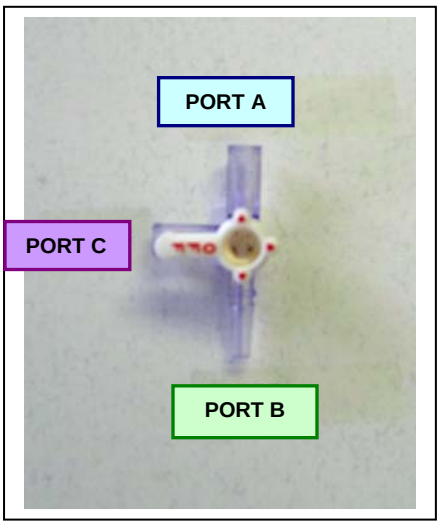
Closed to Port A (Peristaltic Pump / Summa Canister);
Open to Port B (Probe/Well)
Open to Port C (Atmosphere / Digital Manometer / 60 mL Syringe)

The "OFF" handle is turned in such a way that it is directly over Port A. The three small, red arrows opposite the "OFF" handle indicate which ports are open (Ports B & C).

In this valve position when the digital manometer is connected to Port C, a vacuum/pressure reading can be obtained from the probe/well. If the valve is in this position prior to the start of the monitoring (vacuum/pressure gauging, Tedlar™ bag sample collection, and/or summa canister sample collection, set the valve to Position #1 and return to this location at least 30 minutes later.

Valve Position #3: Open for Soil Vapor Sample Collection





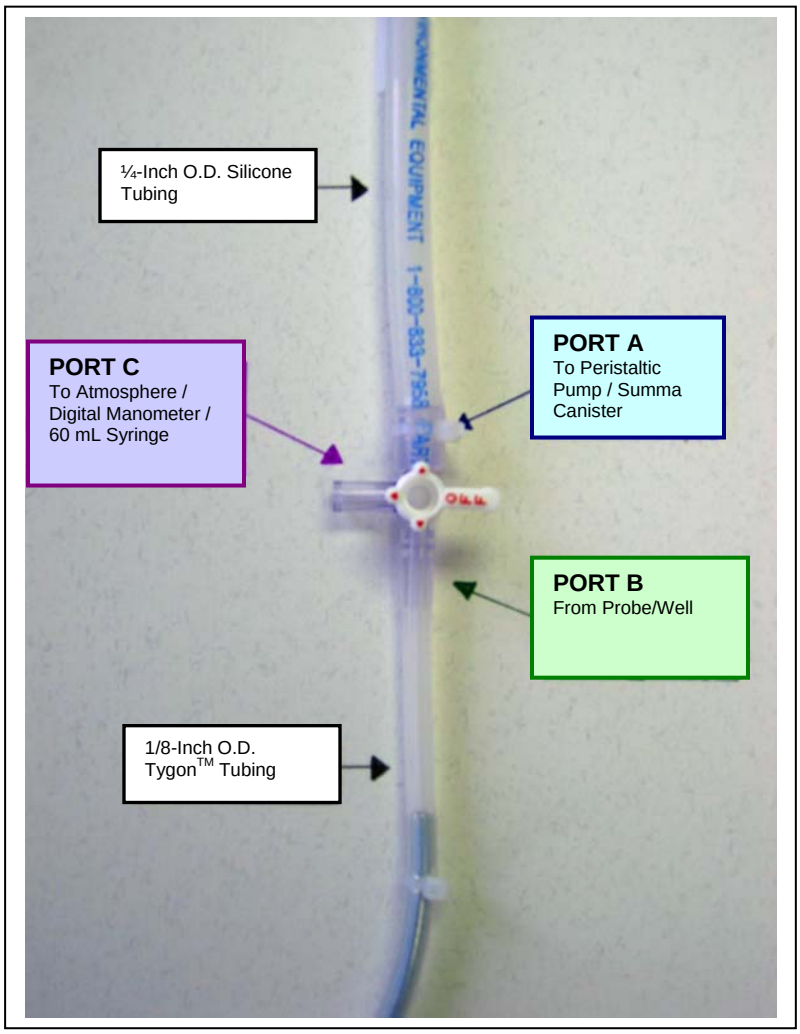
Valve Position #3:

Closed to Port C (Atmosphere / Digital Manometer / 60 mL Syringe);
Open to Port A (Peristaltic Pump / Summa Canister)
Open to Port B (Probe/Well)

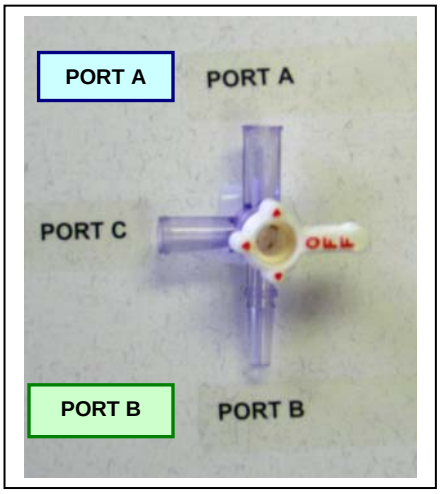
The "OFF" handle is turned in such a way that it is directly over Port C. The three small, red arrows opposite the "OFF" handle indicate which ports are open (Ports A & B).

In this valve position, a soil vapor sample can be collected from the probe/well using the peristaltic pump and Tedlar™ bag or a summa canister. If the valve is in this position prior to the start of the monitoring (vacuum/pressure gauging, Tedlar™ bag sample collection, and/or summa canister sample collection, set the valve to Position #1 and return to this location at least 30 minutes later.

Valve Position #4: Improper Valve Position



PORT C



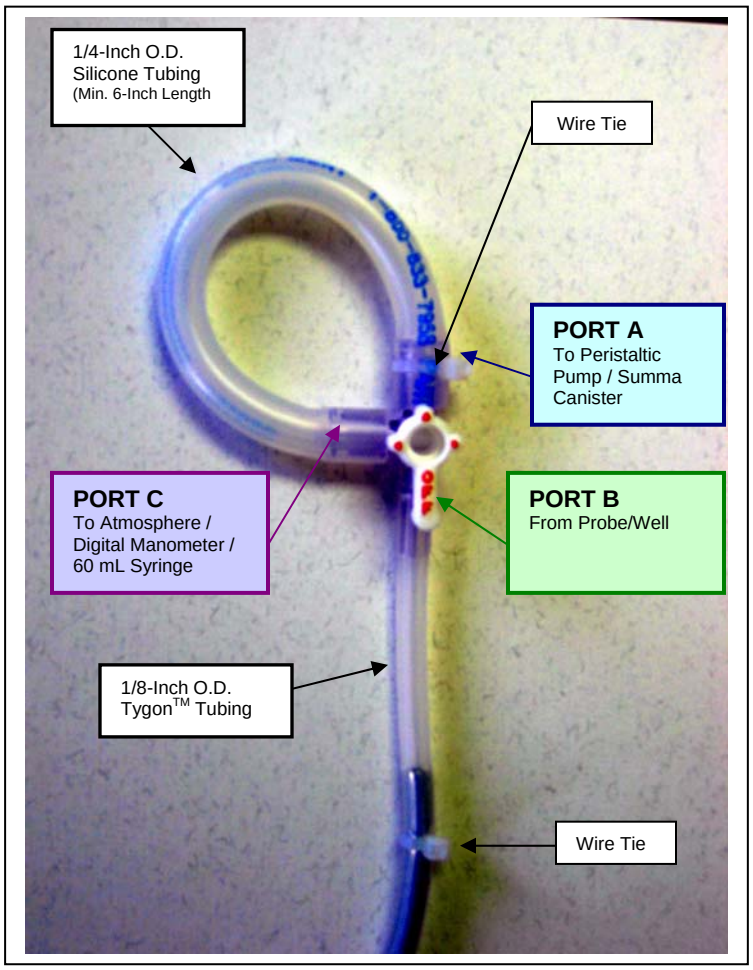
Valve Position #4:

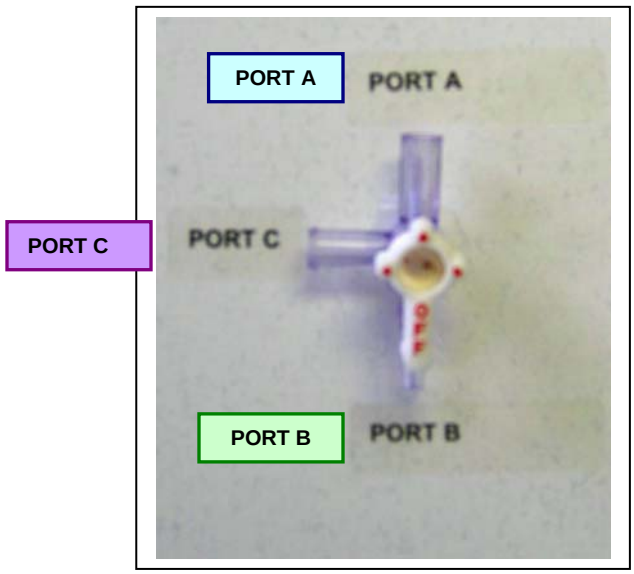
Open to Port A (Peristaltic Pump / Summa Canister);
Open to Port B (Probe/Well)
Open to Port C (Atmosphere / Digital Manometer / 60 mL Syringe)

The "OFF" handle is turned in such a way that it is opposite of Port C. The three small, red arrows opposite the "OFF" handle indicate all ports are open (Ports A, B & C).

In this valve position, the probe/well is open to the atmosphere and, therefore, will vent. In addition, this valve position will allow ambient air into the sample train and invalidate the data. If the valve is in this position prior to the start of the monitoring (vacuum/pressure gauging, Tedlar™ bag sample collection, and/or summa canister sample collection, set the valve to Position #1 and return to this location at least 30 minutes later. The valve should never be in this position.

Post-Monitoring Valve and Tubing Configuration





Post-Monitoring Valve and Tubing Configuration:

Closed to Port B (Probe/Well)
Open to Port A (Peristaltic Pump / Summa Canister);
Open to Port C (Atmosphere / Digital Manometer / 60 mL Syringe)

The 4-way micro-valve is set to position #1. The "OFF" handle is turned in such a way that it is directly over Port B. The three small, red arrows opposite the "OFF" handle indicate which ports are open (Ports A & C). In addition, the silicone tubing (minimum length of six (6) inches) is configured such that it forms a loop between Port A and Port C and a wire tie is used to secure the silicone tubing to Port A.

In this configuration, the probe/well is not open to the atmosphere and, therefore, will not vent. In addition, this configuration minimizes the water infiltration into the 4-way micro-valve. The valve and tubing should be placed in this configuration following vacuum/pressure gauging and soil vapor sample collection.

STANDARD OPERATING PROCEDURE NO. SAS-11-05

FIELD SCREENING FOR FIXED GASES AND SOIL VAPOR CONCENTRATIONS Revision 0

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the guidelines for conducting the field screening soil vapor samples collected using Tedlar™ bag media. The field screening consists of instrument calibration, real-time determination of fixed gases (oxygen and carbon dioxide) levels, percent of lower explosive limit (% LEL), and soil vapor concentrations (as determined using a photoionization detector [PID] and flame ionization detector [FID]), and documentation of field screening results.

2.0 EQUIPMENT AND MATERIALS

- LandTec GA-90 Landfill Gas Analyzer or equivalent
- RAE Systems ppbRAE continuous monitoring PID or equivalent
- Thermo Electron TVA 1000B PID and FID or equivalent
- Calibration Gases:
  - Zero Gas – Hydrocarbon (HC) Free Air
  - Carbon dioxide (CO_2) at 35% by volume
  - Oxygen (O_2) at 4% by volume
  - Isobutylene at 0.5% by volume
  - Methane (CH_4) at 3.25% by volume
  - Isobutylene in air at concentrations of 10, 50 and 1,000 ppmv
  - Methane (CH_4) in air at concentrations of 50, 500, and 5,000 ppmv
- Regulators for gas cylinders
- 1-liter Tedlar™ bag sample media
- ¼-inch outer diameter (O.D.) Teflon™ or Tygon™ tubing cut to length
- Thermo Electron Dilutor Orifice 10:1 (a.k.a. 10-to-1 dilution probe)
- Thermo Electron Dilutor Orifice 25:1 (a.k.a. 25-to-1 dilution probe)

- Thermo Electron Dilutor Orifice 50:1 (a.k.a. 50-to-1 dilution probe)
- Metering valves
- Field Screening Calibration Forms
- Field Screening Spreadsheet and/or Forms
- Miscellaneous tools

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

- Calibration gas cylinders shall be stored in accordance with OSHA and site-specific regulations/guidelines.
- Field screening instruments shall be stored between uses and maintained in accordance with manufacturer guidelines.
- Field screening shall be performed at a fixed location, when practical, with adequate ventilation.
- A ppbRAE or equivalent may be used as an optional screening tool to confirm low level volatile organic compound (VOC) concentrations.

5.0 INSTRUMENT SPECIFICATIONS

Instrument specifications are intended as general guidelines only. Instruments may be substituted based on project/task specific needs.

5.1 LandTec GA-90 or Equivalent

A LandTec GA-90 or equivalent shall be used to measure O_2 and CO_2 levels as percent by volume (%) in soil vapor samples. If required by project/task specific requirements, this instrument may be used to measure the % LEL in soil vapor samples.

5.2 ppbRAE or Equivalent

A ppbRAE or equivalent may be used as an optional screening tool to measure and confirm low level VOCs in soil vapor samples. The ppbRAE or equivalent, when used, shall measure VOCs as parts per billion by volume (ppbv) and/or parts per million by volume (ppmv).

5.3 TVA 1000B or Equivalent

A Toxic Vapor Analyzer (TVA 1000B) or equivalent shall be used to measure low to high level VOCs as ppmv in soil vapor samples. The TVA 1000B or equivalent shall also be used to measure low to high level total hydrocarbons (THC) as ppmv or percent by volume ($\%_V$) in soil vapor samples.

6.0 INSTRUMENT CALIBRATION

In order to ensure the collection of valid levels of fixed gases, O_2 and CO_2, and soil vapor concentrations as total hydrocarbons (THC), proper calibration of the instruments is important. Instruments shall be calibrated prior to field screening in accordance with the manufacturers recommended procedures. Calibration gases shall be introduced directly at a rate of 0.5 liters per minute to the LandTec GA-90 or equivalent since the instrument pump is not required for calibration. Calibration standard gases shall be introduced to the ppbRAE, TVA 1000B PID, and TVA 1000B FID using Tedlar™ bag media which will allow the instrument pump to draw in the calibration gas at the appropriate flow. Following screening activities each day, a post-screening calibration check shall be performed. If the screening instruments are to be used continuously throughout the workday, mid-screening calibration checks shall also be performed. One-point bump

calibration checks shall also be performed on the TVA 1000B or equivalent and associated dilution probe(s) at a frequency of one per two-hours of field screening. Calibration gases with concentrations within the linear range of the instrument shall be used for the pre-screening calibration and post-screening calibration check in addition to the mid-screening and one-point bump calibration checks, when required.

6.1 Pre-Screening Calibration

6.1.1 LandTec GA-90 or equivalent

Prior to the start of field screening, the LandTec GA-90 or equivalent shall be calibrated in accordance with the manufacturers recommended procedures using 4.0% $_V$ O_2 and 35% $_V$ CO_2 standard gases (see Attachment A). The pre-screening calibration shall be documented on the appropriate instrument calibration form (see Attachment A).

6.1.2 ppbRAE or equivalent

Prior to the start of optional, confirmatory low level PID field screening, the ppbRAE or equivalent shall be calibrated in accordance with the manufacturers recommended procedures using hydrocarbon free air (0 ppmv THC by volume) and 10 ppmv isobutylene standard gas (see Attachment A). The pre-screening calibration shall be documented on the appropriate instrument calibration form (see Attachment A).

6.1.3 TVA 1000B or equivalent

Prior to the start of field screening, the PID portion of the TVA 1000B or equivalent shall be calibrated in accordance with the manufacturers recommended procedures using hydrocarbon free air (0% $_V$ THC) and 50 and 1,000 ppmv isobutylene standard gases. The FID portion of the TVA 1000 or equivalent shall be calibrated in accordance with the manufacturers recommended procedures using hydrocarbon free air (0% $_V$ THC) and 50, 500, and 5,000 ppmv methane standard gases (see Attachment A). The pre-screening calibration shall be documented on the appropriate instrument calibration form (see Attachment A).

6.1.4 Dilution Probes

Following the calibration of the TVA 1000B PID and FID, each dilution probe shall be calibrated by adjusting the associated metering valve until the concentration displayed on the instrument is within (+/-) 15% of the target concentration of the designated calibration gases. The following table summarizes the type and concentration of calibration gas, target displayed concentration, and acceptable range for each dilution probe and instrument. The pre-screening calibration shall be documented on the appropriate instrument calibration form (see Attachment A).

Instrument	Dilution Probe	Calibration Gas		Concentration Displayed on Instrument	
		Type	Concentration	Target (ppmv)	Acceptable Range (ppmv)
TVA 1000B PID	10-to-1	Isobutylene	0.5 $\%_V$	500	425 – 575
TVA 1000B FID	10-to-1	Methane	3.25$\%_V$	3,250	2,762 – 3,738
	25-to-1	Methane	3.25$\%_V$	1,300	1,105 – 1,495
	50-to-1	Methane	3.25$\%_V$	650	552 – 748

6.2 Mid- and Post-Screening Calibration Checks

Properly calibrated instruments may drift during the field screening period. In order to ensure the collection of valid data, calibration accuracy checks will be conducted at the conclusion of the field screening each day. If the screening instruments are to be used throughout the workday, mid-screening calibration checks shall also be performed.

6.2.1 LandTec GA-90 or equivalent

The calibration of the LandTec GA-90 or equivalent shall be checked using 4.0 $\%_V$ O_2 and 35% $_V$ CO_2 standard gases. If the observed concentration/level is within (+/-) 15% of the standard gases, the calibration shall be considered adequate. If the observed concentration/level is outside that range, the LandTec GA-90 or equivalent shall be recalibrated. Data obtained since the previous calibration check shall be flagged as estimated values. The following table summarizes the type and concentration of calibration gas, target displayed concentration, and acceptable range for each fixed gas. The calibration checks shall be documented on the appropriate instrument calibration form (see Attachment A).

Fixed Gas	Calibration Gas		Concentration Displayed on Instrument	
	Type	Concentration	Target (%)	Acceptable Range (%)
Oxygen	O_2 Standard	4.0% $_V$	4.0	3.4 – 4.6
Carbon Dioxide	CO_2 Standard	35.0%$_V$	35.0	29.75 – 40.25

6.2.2 ppbRAE or equivalent

The calibration of the ppbRAE or equivalent shall be checked using hydrocarbon free air (0 ppmv THC by volume) and 10 ppmv isobutylene standard gases, if the observed concentration/level is within (+/-) 15% of the calibration gases, the calibration shall be considered adequate. If the observed concentration/level is outside that range, the ppbRAE or equivalent shall be recalibrated. Data obtained since the previous calibration check shall be flagged as estimated values. The following table summarizes the type and concentration of calibration gas, target displayed concentration, and acceptable range for the ppbRAE. The calibration checks shall be documented on the appropriate instrument calibration form (see Attachment A).

Instrument	Calibration Gas		Concentration Displayed on Instrument	
	Type	Concentration	Target (ppmv)	Acceptable Range (ppmv)
ppbRAE	HC Free Air	0.0 ppmv	0.0	0.08 – 0.15
	Isobutylene	10.0 ppmv	10.0	8.5 – 11.5

6.2.3 TVA 1000B or equivalent

Given the wide range of hydrocarbons anticipated, the linearity of the PID response shall be checked using hydrocarbon free air (0% $_V$ THC) and 50 and 1,000 ppmv isobutylene standard gases. The FID response shall be checked using 50, 500, and 5000 ppmv methane standard gases. If the observed concentration/level is within (+/-) 15% of the standard gases, the calibration shall be considered adequate. If the observed concentration/level is outside that range, the TVA 1000B or equivalent shall be recalibrated. Data obtained since the previous calibration check shall be flagged as estimated values. The following table summarizes the type and concentration of calibration gases, target displayed concentration, and acceptable range for each

instrument. The calibration checks shall be documented on the appropriate instrument calibration form (see Attachment A).

Instrument	Dilution Probe	Calibration Gas		Concentration Displayed on Instrument	
		Type	Concentration	Target (ppmv)	Acceptable Range (ppmv)
TVA 1000B PID	None	HC Free Air	0.0 ppmv	0.0	0.08 – 0.15
		Isobutylene	50.0 ppmv	50.0	42.5 – 57.5
			1,000 ppmv	1,000	850 – 1150
TVA 1000B FID	None	HC Free Air	0.0 ppmv	0.0	0.08 – 0.15
		Methane	50.0 ppmv	50.0	42.5 – 57.5
			500 ppmv	500	425 – 575
			5,000 ppmv	5,000	4250 – 5750

6.2.4 Dilution Probes

Following the calibration check of the TVA 1000B PID and FID, each dilution probe and associated metering valve shall be shall be verified using designated type and concentration of standard gas. The dilution probe calibration is considered adequate if the concentration displayed on the instrument is within (+/-) 15% of the target concentration of the designated calibration gas. The following table summarizes the type and concentration of calibration gas, target displayed concentration, and acceptable range for each dilution probe and instrument. The calibration checks shall be documented on the appropriate instrument calibration form (see Attachment A)

Instrument	Dilution Probe	Calibration Gas		Concentration Displayed on Instrument	
		Type	Concentration	Target (ppmv)	Acceptable Range (ppmv)
TVA 1000B PID	10-to-1	Isobutylene	0.5% $_V$	500	425 – 575
TVA 1000B FID	10-to-1	Methane	3.25% $_V$	3,250	2,762.5 – 3,737.5
	25-to-1	Methane	3.25% $_V$	1,300	1,105 – 1,495
	50-to-1	Methane	3.25% $_V$	650	552.5 – 747.5

6.3 Periodic Bump Calibration Checks

Due to the negligible (< 5%) instrument drift throughout a day, the LandTec GA-90 and ppbRAE or equivalent(s) will not undergo periodic bump calibration checks. Given the wide range of hydrocarbons anticipated, one-point, calibration bump checks shall be performed on the TVA 1000B PID and FID, dilution probes, and associated metering valves or equivalents. The period bump calibration check shall be performed at a frequency of one per two-hours of field screening. The calibration is considered adequate if the concentration displayed on the instrument is within (+/-) 15% of the target concentration of the designated calibration gas. If the observed concentration is outside this range, the instrument and/or dilution probe and metering valve shall be recalibrated as appropriate. Data obtained since the previous bump calibration check shall be flagged as estimated values. The following table summarizes the type and concentration of calibration gas, target displayed concentration, and acceptable range for each dilution probe and instrument. The calibration checks shall be documented on the appropriate instrument calibration form (see Attachment A).

Instrument	Dilution Probe	Calibration Gas		Concentration Displayed on Instrument	
		Type	Concentration	Target (ppmv)	Acceptable Range (ppmv)
TVA 1000B PID	None	Isobutylene	50.0 ppmv	50.0	42.5 – 57.5
	10-to-1	Isobutylene	0.5% $_V$	500	425 – 575
TVA 1000B FID	None	Methane	5,000 ppmv	5,000	4250 – 5750
	10-to-1	Methane	3.25%$_V$	3,250	2,762 – 3,738
	25-to-1	Methane	3.25%$_V$	1,300	1,105 – 1,495
	50-to-1	Methane	3.25%$_V$	650	552 – 748

7.0 SAMPLE SCREENING

Soil vapor samples collected in Tedlar™ bags shall be screened at a fixed location, whenever practical. Since samples may have 1) concentrations above the measurement range of the instrument or 2) insufficient oxygen content to analyze reliably, the order of the screening is important to the identification of these situations. The screening order is also dictated by the sample flow rates, which vary by instrument, and the sample volume.

7.1 Screening Procedures

Prior to field screening, the well/sample ID, sample date, and sample time shall be recorded on the appropriate field form and/or spreadsheet (see Attachment C). Once the screening data and time have also been recorded on the appropriate field form and/or spreadsheet (see Attachment C), the field screening shall commence. The soil vapor samples shall be analyzed in the following order:

- Fixed gases (O_2 and CO_2)
- Percent of lower explosive limit (% LEL) - If required by the project or task
- Soil vapor concentrations (VOCs) as determined using a PID
- Soil vapor concentrations (THC) as determined using a FID

The field screening shall adhere to the procedure outlined in the Field Screening Procedure Flow Chart provided in Attachment B. Following screening the Tedlar™ bag sample media shall be discarded.

7.2 Reporting

Field screening results as observed on the instruments, fixed gases levels (O_2 & CO_2), percent lower explosive limit, and soil vapor concentrations, as determined using a PID and FID, shall be recorded in the appropriate spreadsheet or on the appropriate field form (see Attachment C). The use of a dilution probe shall also be documented in the appropriate spreadsheet or on the appropriate field form (see Attachment C). *Please note: Concentrations as determined using a PID and FID shall be corrected for the use of dilution probe(s).* If the concentration of the vapor sample exceeds the operating range of the instrument, with or without the use of a dilution probe, it shall be marked as "estimated". If a flame-out of the FID occurs, "FO" shall be recorded as the default value for the affected sample. If the flame-out was not the result of 1) insufficient sample flow, 2) FID capsule contamination, or 3) insufficient oxygen in the sample (<14% when adjusted to account for the use or absence of a dilution probe), the upper dynamic range of the instrument, which has been adjusted for the use of or absence of a dilution probe, shall be used as the corrected FID reading. In this case, the reading shall be flagged as estimated. These situations shall be documented in the appropriate spreadsheet or on the appropriate field form.

8.0 SAMPLE HOLD TIMES

Soil vapor samples collected using Tedlar™ bag media shall be field screened at a fixed location, if practical, within thirty-six (36) hours of sample collection.

9.0 REFERENCES AND ADDITIONAL RESOURCES

Field Environmental Instruments, LANDTEC GA-90 Gas Analyzer Specifications and Features.

LANDTEC, GA-90 Landfill Gas Analyzer Operation Manual, Version MK2C1.12.

RAE Systems, 1999, Portable Continuous ppb VOC Detector Monitor Specifications and Features.

RAE Systems, 1999, Using the MiniRAE 2000 & ppbRAE plus.

Thermo Electron Corporation, 2003, Product Overview TVA-1000B Toxic Vapor Analyzer.

Thermo Electron Corporation, 2003, TVA-1000B Toxic Vapor Analyzer Instruction Manual P/N BK3500, December.

USEPA, 2007, Guidance for Preparing Standard Operating Procedures (SOPs), EPA/600/B-07/001.

ATTACHMENT A
INSTRUMENT CALIBRATION FORMS

ATTACHMENT A-1
LANDTEC GA-90 LANDFILL GAS ANALYZER OR EQUIVALENT

FIELD SCREENING INSTRUMENT CALIBRATION FORM
LandTec GA-90 or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION | **INSTRUMENT INFORMATION**

Date: _____ **Make:** _____
Screener: _____ **Model:** _____
Assistant: _____ **Serial #:** _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response	Response within Tolerances (circle one)	Comments
		Type	Conc.			
	Pre-Screening Calibration[R]	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Mid-Screening Calibration Check*	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Post-Screening Calibration Check[R]	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Mid-Screening Recalibration*	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Mid-Screening Recalibration*	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	

Notes: 1. [R] = Required 2. * = If necessary 3. % = percent by volume

ATTACHMENT A-2
ppbRAE or EQUIVALENT

FIELD SCREENING INSTRUMENT CALIBRATION FORM
ppbRAE or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION | **INSTRUMENT INFORMATION**

Date: _____ **Make:** _____
Screener: _____ **Model:** _____
Assistant: _____ **Serial #:** _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard Type	Calibration Standard Conc.	Instrument Response	Response within Tolerances (circle one)	Comments
	Pre-Screening Calibration[R]	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Calibration Check*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Post-Screening Calibration Check[R]	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	

Notes: 1. [R] = Required 2. * = If necessary 3. ppmv = parts per million by volume

ATTACHMENT A-3
TVA-1000B TOXIC VAPOR ANALYZER OR EQUIVALENT

FIELD SCREENING INSTRUMENT CALIBRATION FORM
TVA 1000 (FID) or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION

Date: _____
Screener: _____
Assistant: _____

INSTRUMENT INFORMATION

Make: _____
Model: _____
Serial #: _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response				Response(s) within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe	w/ 25-to-1 Dilution Probe	w/ 50-to-1 Dilution Probe		
	Pre-Screening Calibration[R]	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Mid-Screening Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	

CALIBRATION AND CALIBRATION CHECK INFORMATION (Continued)									
Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response				Response(s) within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe	w/ 25-to-1 Dilution Probe	w/ 50-to-1 Dilution Probe		
	Post-Screening Calibration Check[R]	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	

Notes: 1. [R] = Required 2. * = If necessary 3. ppmv = parts per million by volume 4. N/A = Not Applicable

FIELD SCREENING INSTRUMENT CALIBRATION FORM
TVA 1000 (PID) or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION

Date: _____
Screener: _____
Assistant: _____

INSTRUMENT INFORMATION

Make: _____
Model: _____
Serial #: _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response		Response within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe		
	Pre-Screening Calibration[R]	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Mid-Screening Calibration Check*	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Post-Screening Calibration Check[R]	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	

CALIBRATION AND CALIBRATION CHECK INFORMATION (Continued)							
Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response		Response within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe		
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	

Notes: 1. R = Required 2. * = If necessary 3. ppmv = parts per million by volume

ATTACHMENT B
FIELD SCREENING PROCEDURE FLOW CHART

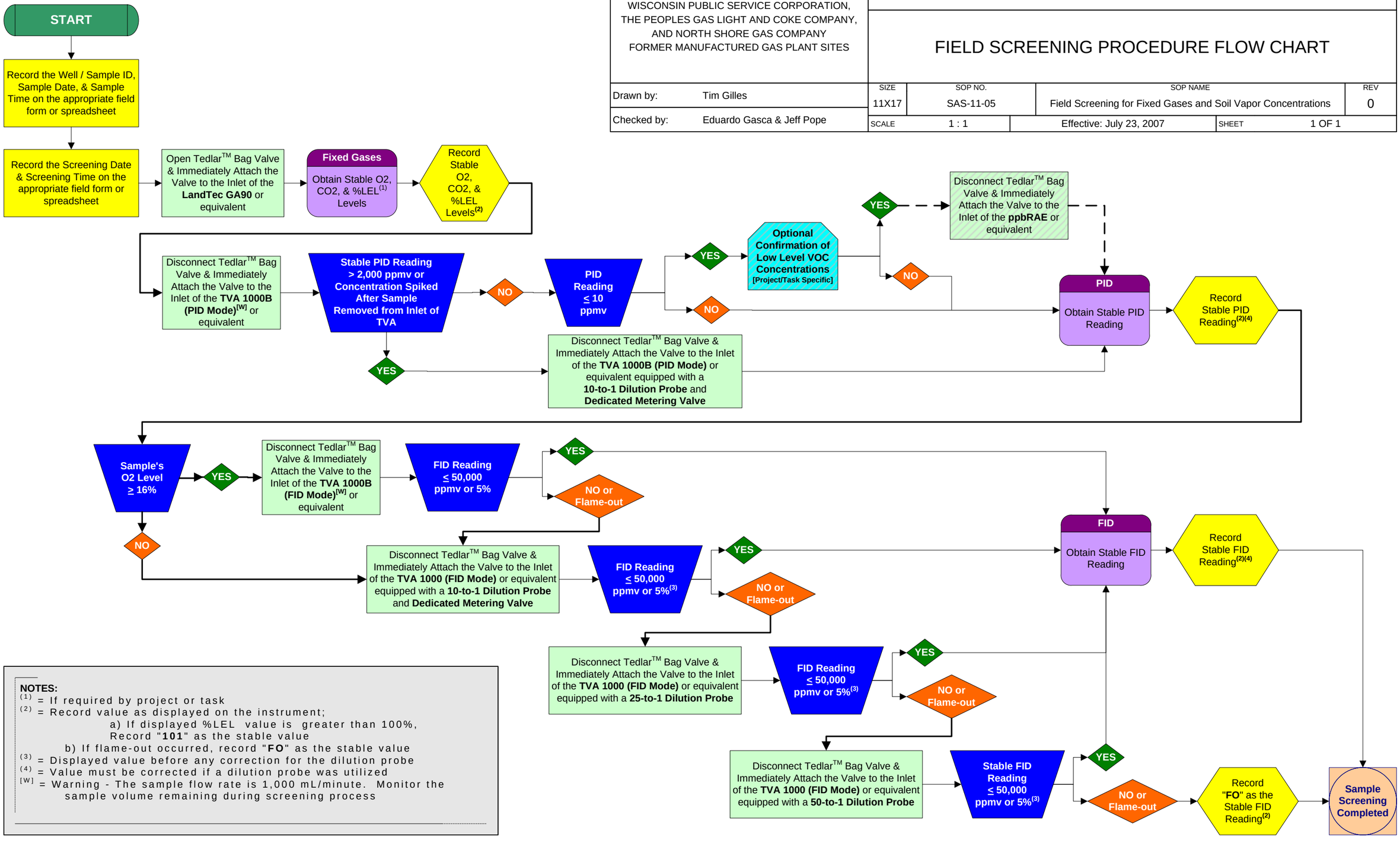
WISCONSIN PUBLIC SERVICE CORPORATION,
THE PEOPLES GAS LIGHT AND COKE COMPANY,
AND NORTH SHORE GAS COMPANY
FORMER MANUFACTURED GAS PLANT SITES

SOP SAS-11-05 ATTACHMENT B

FIELD SCREENING PROCEDURE FLOW CHART

Drawn by:	Tim Gilles
Checked by:	Eduardo Gasca & Jeff Pope

SIZE	SOP NO.	SOP NAME	REV
11X17	SAS-11-05	Field Screening for Fixed Gases and Soil Vapor Concentrations	0
SCALE 1 : 1	Effective: July 23, 2007	SHEET 1 OF 1	



NOTES:

(1) = If required by project or task

(2) = Record value as displayed on the instrument;
a) If displayed %LEL value is greater than 100%, Record "**101**" as the stable value
b) If flame-out occurred, record "**FO**" as the stable value

(3) = Displayed value before any correction for the dilution probe

(4) = Value must be corrected if a dilution probe was utilized

[W] = Warning - The sample flow rate is 1,000 mL/minute. Monitor the sample volume remaining during screening process

ATTACHMENT C
FIELD SCREENING RESULTS SPREADSHEET/FORM

FIXED GASES AND SOIL VAPOR CONCENTRATION FIELD SCREENING DATA

PROJECT INFORMATION		GENERAL INSTRUMENT INFORMATION		SCREENER INFORMATION	
Project Name:		Fixed Gases:		Screener's Name:	
Project Number:		PID (Low Level Confirmation):		Screener's Title:	
Task Name:		PID (Low-High Level):		Assistant's Name:	
Task/Project Manager:		FID (Low-High Level):		Assistant's Title:	

FIELD SCREENING RESULTS

WELL ID or SAMPLE ID	SAMPLE DATE	SAMPLE TIME (24-Hour)	SCREENING DATE	SCREENING TIME (24-Hour)	Observed Field Screening Values[1], Units, and Dilution Values[2]									Corrected Value[3]		COMMENTS
					O_2 (%)	CO_2 (%)	% LEL[4] (%)	PID	PID UNITS (circle one)	PID Dilution Value[2] (circle one)	FID	FID UNITS (circle one)	FID Dilution Value[2] (circle one)	PID (ppmv)	FID (ppmv)	
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			

FIELD SCREENING RESULTS																
WELL ID or SAMPLE ID	SAMPLE DATE	SAMPLE TIME (24-Hour)	SCREENING DATE	SCREENING TIME (24-Hour)	Observed Field Screening Values[1], Units, and Dilution Values[2]									Corrected Value[3]		COMMENTS
					O_2 (%)	CO_2 (%)	% LEL[4] (%)	PID	PID UNITS (circle one)	PID Dilution Value[2] (circle one)	FID	FID UNITS (circle one)	FID Dilution Value[2] (circle one)	PID (ppmv)	FID (ppmv)	
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			

FIELD SCREENING RESULTS																	
WELL ID or SAMPLE ID	**SAMPLE DATE**	**SAMPLE TIME (24-Hour)**	**SCREENING DATE**	**SCREENING TIME (24-Hour)**	**Observed Field Screening Values[1], Units, and Dilution Values[2]**									**Corrected Value[3]**		**COMMENTS**
					O_2 (%)	**CO_2 (%)**	**% LEL[4] (%)**	**PID**	**PID UNITS (circle one)**	**PID Dilution Value[2] (circle one)**	**FID**	**FID UNITS (circle one)**	**FID Dilution Value[2] (circle one)**	**PID (ppmv)**	**FID (ppmv)**	
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			

Notes: [1] = As observed on the instrument's display; If flame-out occurs, record "FO" as the default value.

[2] = Dilutions Values (Dilution Probe Specific): No Dilution Probe Used - Circle "1"; 10-to-1 Dilution Probe Used - Circle "10"; 25-to-1 Dilution Probe Used - Circle "25"; 50-to-1 Dilution Probe Used - Circle "50"

[3] = Calculated based on the units and dilution value or, in the case of a flame-out when sufficient oxygen is present, the upper dynamic range of the instrument multiplied by the dilution value.

[4] = If required by project or task

E = Estimated Value: Corrected value exceeds the upper dynamic range of the instrument or flame-out due to concentrations above the instruments range occurred.

ppbv = Parts per billion volume

ppmv = Parts per million volume

% = Percent by volume

N/A = Not Applicable

FO = Instrument Flame Out (FID Only)

STANDARD OPERATING PROCEDURE NO. SAS-11-06

SOIL GAS SAMPLING Revision 1

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides information on soil-gas sampling using an active sampling approach to assess the vapor intrusion pathway. Soil gas will be sampled using dedicated gas vapor tips and the associated installation kit or direct-push rig. Soil gas samples will be collected from the unsaturated zone to provide measurements of soil gas that may potentially enter a building.

2.0 EQUIPMENT AND MATERIALS

- Rotary hammer drill (or equivalent) with a 1 3/8-inch diameter bit;
- Retractable gas vapor tip (GVP);
- Expendable GVP replacements;
- Hand Tools, including a hammer, needle-nose pliers, and trowel;
- Tubing receptacle;
- Teflon compression fittings to connect sampling points at “T” connection;
- “T” Swagelok (compression) or equivalent fitting;
- Stainless steel tubing;
- Gas sampling pump capable of extracting 200 milliliters per minute (mL/min);
- 4-way Teflon micro-valve;
- 1/4-inch O.D. Teflon tubing;
- VOC-free caulk;
- Nitrile gloves;
- Summa canisters with flow controllers, vacuum gauge, and shipping container;
- Sample labels;
- Chain of custody forms and seals;

- Field air monitoring instruments, as specified in the Work Plan (e.g. photo ionization detector, multi-gas monitors, etc.);
- Location markers (e.g. pin flags, wooden stakes, flagging tape, etc.);
- Granular bentonite;
- Asphalt cold patch or cement, as appropriate for site restoration;
- Decontamination materials;
- DOT-specified 55-gallon drum; and
- Field logbook and/or appropriate field form(s);

3.0 HEALTH AND SAFETY

Potentially hazardous conditions relating to chemicals under investigation, equipment and tools in use, utility services in investigation areas, or certain work activities may exist on the site. Protocols are established in each site-specific Health & Safety Plan (HASP) based on corporate health and safety policies and manuals, past field experience, specific site conditions, and chemical hazards known or anticipated to be present from available site data. Before site operations begin, all employees, and subcontractor personnel will have read and understood the HASP and all revisions. Before work begins, all site project staff will sign an agreement and acknowledgment form indicating that they have read and fully understood the HASP and their individual responsibilities, and fully agree to abide by the provisions of the HASP.

4.0 CONSIDERATIONS

Variations in chemical-specific characteristics, geologic conditions, and atmospheric influences can affect soil-gas sampling results. For this reason, it is important to understand factors the may influence the reported data when collecting soil-gas data. In all cases, site-specific factors should be carefully evaluated prior to initiation of sampling to obtain representative soil-gas data.

Prior to any soil-gas sampling, soil type must be evaluated for suitability of sampling. Soils with smaller grain sizes have smaller pore spaces and are less permeable, which may reduce the ability for soil gas to be released from the subsurface. For example, clays have the smallest grain size and significantly restrict soil gas migration. Soil moisture also limits the ability for soil gas to be released from the subsurface because moisture trapped in the pore space of sediments can inhibit or block soil-gas flow. Seasonal and geographical

variations in soil moisture content can affect air permeabilities. In addition, manmade and naturally occurring preferential pathways (e.g. utility corridors, lenses of coarse-grained materials within fine-grained materials, etc.) may also affect soil-gas migration and shall be considered prior to soil-gas sampling.

Reliability of soil-gas sampling may be improved by using fixed probes and by ensuring that leakage of atmospheric air into the samples is avoided during purging or sampling. To avoid dilution of the sampling region from leakage, the minimum purge volume deemed adequate to flush the sampling system should be removed, and soil-gas samples should be collected from the most permeable zones in the vadose zone when possible. Site-specific information concerning soil lithology, grain size analysis, soil moisture, and soil-gas permeability may be obtained by performing three soil borings in the immediate area of the sampling locations in advance of the soil-gas sampling. In addition, previous site investigation sample results, when available, should be used to determine the placement of the soil-gas sampling locations.

Since oxygen, carbon dioxide, and nitrogen can be sampled using a multi-gas monitor to give real-time results, parallel analysis of oxygen, carbon dioxide, and nitrogen in soil-gas may also be used to help assess the reliability of a given sample result.

5.0 SOIL VAPOR PROBE INSTALLATION

Prior to installation at each soil vapor probe location, the area will be inspected for clearance of existing utility lines and other obstructions near the sample location. The soil vapor probes will then be installed into the ground surface using a hammer drill connected to drive rods or a direct-push rig. Installation using a hammer drill should be used when depths of less than 10 feet are desired. For depths greater than 10 feet, a direct-push rig will more efficiently drive the probe rods. The soil vapor probes consist of a stainless steel drive tip which is connected to a screen with a length between 2 to 6 inches and diameter of at least 1/8-inch but no larger than 1/2-inch. At the top of the screen, a stainless steel hose barb allows for a connection to Teflon™ or stainless steel tubing for purging and sample collection. Soil gas probes installed at depths greater than 10 feet should be constructed with stainless steel tubing for durability and stability. After the probe is driven to the desired depth, the rods will be removed and a filter pack containing sand will be set to within 2 inches above and below the vapor probe. Above the sand filter pack, granular bentonite will be

placed and hydrated in two-foot lifts to ground surface. This bentonite will provide an airtight seal between the soil gas probe and the ambient air. Probes should not be installed shallower than two feet below ground surface (bgs). Each probe will be allowed to set for at least 24 hours before sampling takes place.

6.0 SOIL VAPOR SAMPLING PROCEDURES

Subsurface soil vapor will not be sampled if measurable precipitation or irrigation near the sampling location has occurred within the previous five days. The increased soil moisture can decrease soil permeability and cause the soil vapor sample results to be biased low.

6.1 SAMPLE TRAIN ASSEMBLY

Samples will be collected using evacuated batch-certified 1 liter (L) or smaller Summa™ canisters equipped with dedicated flow regulators and integrated particulate filters. A flow regulator/particulate filter and vacuum gauge will be attached to each canister as described in the *Summa Canister Instructions* provided by the laboratory. Canisters, flow regulators/particulate filters, and vacuum gauges will be supplied by the laboratory.

When probe installation is complete, Teflon™ tubing will extend from the probe to the ground surface. The Teflon™ tubing will be connected to a two-way and three-way stopcock assembly. One output of the stopcock assembly will be connected to the Summa™ canister using a Swagelok™ fitting. The other output of the stopcock assembly will be connected to a lung box containing a Tedlar™ bag. Use of dedicated tubing will avoid cross-contamination between probes. A new pair of Nitrile gloves should be worn while connecting the sample assembly for each soil vapor probe.

When collecting duplicate or QA split samples, two separate canister assemblies are connected using a stainless steel “T” fitting, and the “T” fitting is then connected to the Teflon™ tubing assembly described in the previous paragraph. The “T” fitting will be provided by the laboratory.

6.2 PURGING SOIL VAPOR PROBES

Allow the probe to equilibrate for a minimum of 24 hours from the time of installation before initiating purge procedures. Teflon™ tubing coming from the soil vapor probe will be connected to a lung box containing a Tedlar™ bag. The vapor probe will be purged during the chemical leak test by removing a volume of air

equal to three times the volume of the sample probe and tubing. Purging will be conducted using a flow rate of 100 to 200 milliliters per minute (mL/min). Given the small volume of the sample probes, purge air can be discharged to the atmosphere.

6.3 HELIUM LEAK TESTING

The purpose of the chemical leak test is to ensure that the sub slab sample port and probe assembly is properly set and not leaking. A leaking probe assembly could result in a leakage of ambient air into the sample, potentially biasing the sample. Prior to sampling, a chemical leak test will be performed using helium as a tracer gas. The ambient air inside the shroud will be replaced with helium graded at 99.9 percent purity or higher until the atmosphere consists of a minimum of 20 percent helium. It should be noted that concentrations of 60 percent to 80 percent helium have routinely been observed in the shroud during prior field testing. This will be accomplished by inserting Teflon™ tubing through a ¼ inch hole in the shroud and attaching the other end to the helium canister. The helium canister will then be opened, and the shroud atmosphere will be continuously monitored by a Dielectric Technologies Model MGD-2002 Multi-Gas Detector (or equivalent) until the percentage of helium inside the shroud reaches a minimum of 20 percent and the readings on the Multi-Gas Detector (or equivalent) stop increasing. The final helium concentration inside the shroud will be recorded on the Field Data Air Sampling Form. The final helium concentration inside the shroud will be multiplied by 10 percent (0.1) to determine the allowable concentration of helium in the Tedlar™ bag sample. Both the final helium concentration inside the shroud and the calculated allowable concentration in the Tedlar™ bag will be recorded on the Field Data Air Sampling Form (See Attachments).

After the target atmosphere is established, the two-way and three-way stopcocks will be opened to the lung box, which contains a 1 L Tedlar™ bag. An air pump attached to the lung box via Teflon™ tubing will be used to evacuate the existing air inside the lung box, which will in turn cause the 1 L Tedlar™ bag to fill. Once filled, the 1 L Tedlar™ bag will be removed from the lung box and the air inside will be measured using the Model MGD-2002 Multi-Gas Detector (or equivalent) for the presence of helium. The concentration of helium measured inside the Tedlar™ bag will be recorded on the Field Data Air Sampling Form. If the concentration of helium in the sample is below the calculated allowable concentration (i.e., less than 10 percent of the concentration inside the helium shroud), proceed with the mechanical leak test and sample collection as described in Sections 6.4 and 6.5.

Corrective actions to mitigate leaks in the sub-slab soil vapor probe will be performed when the helium concentration in the Tedlar™ bag sample exceeds 10 percent of the starting concentration in the helium shroud. Corrective actions will be performed in the field and will initially involve resealing the probe base with beeswax and repeating the helium leak test. If resealing and retesting fails to produce acceptable leak test results after two attempts, the probe will be abandoned and a new probe will be installed. Samples will not be collected for submittal for laboratory analysis when the helium concentration in the Tedlar™ bag sample exceeds 10 percent of the starting helium concentration in the shroud.

6.4 MECHANICAL LEAK TESTING

The mechanical leak test will be performed immediately after completing the helium leak test. The mechanical leak test will be completed by closing the two-way stopcock and turning the valve on the three-way stopcock to close the tubing connected to the lung box assembly. This will close the connection between the two-way stopcock and the lung box assembly and open the connection between the two-way stopcock and the Summa™ canister. Vacuum test the connections between the Summa™ canister and stopcock by opening the canister valve to place a test vacuum on the assembly for 10 minutes. The start time and initial vacuum, as well as the stop time and final vacuum, will be recorded on the Field Data Air Sampling Form and in the field logbook. If gauge vacuum can not be maintained for 10 minutes, work shall be suspended and all fittings in the sample assembly will be checked. Retest the sample assembly. If vacuum still can not be maintained by 10 minutes, sampling activities will be discontinued until leak can be identified and addressed.

If gauge vacuum was maintained for 10 minutes, close the canister valve and immediately proceed with sample collection as described in Section 6.5. Since the fitting that connects the tubing from the sub-slab probe to the two-way stopcock cannot be leak tested through either the helium or mechanical leak tests, this fitting will be sealed with Teflon™ tape and beeswax.

6.5 SAMPLE COLLECTION

Sample location information, meteorological conditions (temperature, barometric pressure, wind speed/direction, and relative humidity), and results of the field screening analysis shall be recorded on a Field

Data Air Sampling Form. Meteorological data will be obtained online from the nearest National Weather Service measuring station. Digital photos will be taken of each sample location and sample assembly.

Open the sample canister valve to begin sample collection. The time and initial vacuum when sample collection starts shall be recorded on the Field Data Air Sampling Form. The laboratory-provided flow regulators will be calibrated for a 5- to 10-minute sample duration, which correlates to a flow rate of 100 to 200 mL/min. Close the sample canister valve when the vacuum gauge indicates approximately 5 inches Hg (mercury) of vacuum remain in the canister. Sample collection should take approximately 5 minutes for a 1L Summa™ canister connected to a 200 mL/min flow regulator. The time sample collection was stopped and final vacuum shall be recorded on the Field Data Air Sampling Form. Remove the flow regulator/particulate filter and vacuum gauge assembly and replace the laboratory-supplied brass plug on the canister. Disconnect the sample tubing assembly and replace the plug on the soil vapor probe.

Label the sample canister and record on the COC the sample name, date and time the sample was collected, the canister and flow controller serial numbers, and the final vacuum gauge reading. Samples shall not be chilled or subjected to extreme temperature or pressure fluctuations. Samples will be shipped for analysis of VOCs by USEPA Method TO-15.

6.6 QUALITY CONTROL

QC samples will be collected during soil vapor sampling activities. Trip blanks and field duplicates will be collected as necessary. Field duplicates will be collected at the rate of one duplicate sample per 20 soil vapor samples.

A trip blank, consisting of an unopened evacuated canister, will be shipped with the sub-slab vapor samples with each sample shipment. Trip blanks can consist of either unopened fully evacuated canisters or canisters that have been fully charged with zero grade air by the laboratory. Since a fully charged canister has no vacuum with which to pull contaminants into the canister, a fully evacuated canister has a better likelihood of capturing potential transit-related contamination. The trip blank will be provided by the laboratory.

7.0 EQUIPMENT DECONTAMINATION PROCEDURES

All decontamination will be performed according to SAS-04-04.

8.0 INVESTIGATION-DERIVED WASTE (IDW)

The vapor probe installation and sampling will generate small amounts of solid IDW including, concrete dust, gloves, and tubing. This material will be bagged and disposed of as a municipal waste in accordance with applicable regulations. No liquid IDW will be generated. Further discussion of IDW can be found in Section 9 of the *Multi-Site Field Sampling Plan, Former Manufactured Gas Plant Sites, Revision 3", February 20, 2008.*

APPENDIX B

FIELD FORMS

BOREHOLE / WELL ABANDONMENT FIELD FORM

PROJECT INFORMATION

Site: _____ Client: _____

Project Number: _____ Task #: _____ Start Date: _____ Time: _____

Field Personnel: _____ Finish Date: _____ Time: _____

GENERAL INFORMATION

Ownership (Controlling Party): _____

Street Address: _____

City: _____

County: _____

State: _____ Zip: _____

Township: _____ Range: _____ Section: _____

_____ 1/4 of the _____ 1/4 of the _____ 1/4

If Known, Latitude: _____ Longitude: _____

If Known*, Northing: _____ Easting: _____

*Coordinate System: _____

Reason for Abandonment:

Permit Number (If applicable): _____

BOREHOLE / WELL INFORMATION

Borehole / Well ID: _____ Unique Well ID:

Installation Date: _____

☐ Borehole

☐ Monitoring Well ☐ Water Well — Attach Well Completion Report, if available

☐ Other (specify): _____

Construction Type:

☐ Drilled ☐ Driven (Sandpoint)

☐ Other (specify): _____

Formation Type:

☐ Unconsolidated Materials ☐ Bedrock

Borehole/Well Details:

Borehole Diameter: _____ Inches

Total Borehole Depth: _____ FT BGS

Casing Diameter: _____ Inches ☐ Not Applicable

Total Casing Depth: _____ FT BGS ☐ Not Applicable

Depth to Water: FT BGS ☐ Not Encountered

SEALING INFORMATION

Pump & Piping Removed? ☐ Yes ☐ No ☐ Not Applicable

Liner(s) Removed? ☐ Yes ☐ No ☐ Not Applicable

Screen Removed? ☐ Yes ☐ No ☐ Not Applicable

Entire Casing Removed? ☐ Yes ☐ No* ☐ Not Applicable

If No, Upper 2 feet Removed? ☐ Yes ☐ No

Method of Sealing Material Placement:

☐ Conductor Pipe - Gravity ☐ Tremie Pipe - Pumped

☐ Screened & Poured ☐ Other (specify): _____

Sealing Material Rose to Surface? ☐ Yes ☐ No

Material Settled After 24 Hours? ☐ Yes* ☐ No

*If Yes, Was Hole Re-Topped? ☐ Yes ☐ No

Sealing Material Used	From	To	Volume/Quantity
	Surface		

SEALING WORK PERFORMED BY

Individual's Name: _____ License Number:

Company Name: _____

Street Address: _____

City: _____ State: _____ Zip: _____

Request for Chemical Analysis and Chain of Custody Record

Send Results to:	Laboratory:	Document Control No.:
	Address:	Lab. Reference No. or Episode I
Attention:	City/State/ZIP:	
	Telephone:	
Project Number:		Sample Type
Site Name:		Matrix

Sample Number			Sample Event		Sample Depth (in feet)		Sample Collected		Matrix			Number of Containers	Parameter/Method Code						Remarks
Group or SWMU Name	Sample Point	Sample Designator	Round	Year	From	To	Date	Time	Liquid	Solid	Gas								

Sampler *(Print Name)*:	Sampler *(signature)*:	Custody Seal Number	Special Instructions

Relinquished By *(signature)*: 1.	Date/Time	Received By *(signature)*: 1.	Date/Time	Ice Present in Container: Yes ☐ No ☐	Temperature Upon Receipt:
Relinquished By (signature): 2.	Date/Time	Received By (signature): 2.	Date/Time	Laboratory Comments:	

DISTRIBUTION
Owner
Project Manager

Construction Progress Report

Owner _____ Page _____ of _____

Project Name _____ Project No. _____

Contract Name _____ Contract No. _____

Contractor _____

Construction Progress Report: Period _____ to _____

NOTES	REPORTED BY
1. Construction Progress Reports to be on daily, weekly, or monthly basis as determined by the project manager and owner. 2. Attach Project Weather Report, if applicable. 3. Report contractor's daily labor and equipment as required by the project manager and owner.	Date

Drilling Log

	Project Name	Project No.	Boring/Monitoring Well Number
	Site-Specific Coordinates	Ground Elevation	Page 1 of 1
	Total Depth (feet) / Hole Size (inches)	Driller (s)	
Drilling Rig		Drilling Company	
Date / To	Logged By:	Reviewed by:	Approved by:

Elevation (feet)	Depth (feet)	Description	Graphic Log	SAMPLING: Sample Type	Sample Interval	Blow Counts per 0.5'	N Value	Sample Recovery/Length (feet)	Penetro-meter (TSF)	PID Reading (PPM)	Remarks (▽ Depth to water while drilling; ▼ Depth to water after drilling)
	1										
	2										
	3										
	4										
	5										
	6										
	7										
	8										
	9										
	10										
	11										
	12										
	13										

ENVIRONMENTAL LOG COPY OF OSI 2003.GPJ BURNS_MO.GDT 8/30/07

FIELD SCREENING INSTRUMENT CALIBRATION FORM
LandTec GA-90 or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION | **INSTRUMENT INFORMATION**

Date: _____ **Make:** _____
Screener: _____ **Model:** _____
Assistant: _____ **Serial #:** _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response	Response within Tolerances (circle one)	Comments
		Type	Conc.			
	Pre-Screening Calibration[R]	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Mid-Screening Calibration Check*	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Post-Screening Calibration Check[R]	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Mid-Screening Recalibration*	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	
	Mid-Screening Recalibration*	O2	4.0%		Yes / No	
		CO2	35.0%		Yes / No	

Notes: 1. [R] = Required 2. * = If necessary 3. % = percent by volume

FIELD SCREENING INSTRUMENT CALIBRATION FORM
ppbRAE or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION | **INSTRUMENT INFORMATION**

Date: _____ **Make:** _____
Screener: _____ **Model:** _____
Assistant: _____ **Serial #:** _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard Type	Calibration Standard Conc.	Instrument Response	Response within Tolerances (circle one)	Comments
	Pre-Screening Calibration[R]	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Calibration Check*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Post-Screening Calibration Check[R]	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		Yes / No	
		Isobutylene	10.0 ppmv		Yes / No	

Notes: 1. [R] = Required 2. * = If necessary 3. ppmv = parts per million by volume

FIELD SCREENING INSTRUMENT CALIBRATION FORM
TVA 1000 (FID) or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION

Date: _____
Screener: _____
Assistant: _____

INSTRUMENT INFORMATION

Make: _____
Model: _____
Serial #: _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response				Response(s) within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe	w/ 25-to-1 Dilution Probe	w/ 50-to-1 Dilution Probe		
	Pre-Screening Calibration[R]	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Mid-Screening Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	

CALIBRATION AND CALIBRATION CHECK INFORMATION (Continued)									
Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response				Response(s) within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe	w/ 25-to-1 Dilution Probe	w/ 50-to-1 Dilution Probe		
	Post-Screening Calibration Check[R]	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	50.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	500 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	
	Bump Calibration Check*	Free Air	0.0 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	5,000 ppmv		N/A	N/A	N/A	Yes / No	
		Methane	32,500 ppmv	N/A				Yes / No	

Notes: 1. [R] = Required 2. * = If necessary 3. ppmv = parts per million by volume 4. N/A = Not Applicable

FIELD SCREENING INSTRUMENT CALIBRATION FORM
TVA 1000 (PID) or Equivalent

Form Revision 0

PROJECT INFORMATION

Project Name: _____ **Task Name:** _____
Project Number: _____ **Task/Project Manager:** _____

FIELD SCREENING TEAM INFORMATION | **INSTRUMENT INFORMATION**

Date: _____ **Make:** _____
Screener: _____ **Model:** _____
Assistant: _____ **Serial #:** _____

CALIBRATION GAS INFORMATION

Manufacturer	Cal. Gas Type	Lot Number	Expiration Date

CALIBRATION AND CALIBRATION CHECK INFORMATION

Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response		Response within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe		
	Pre-Screening Calibration[R]	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Mid-Screening Calibration Check*	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Post-Screening Calibration Check[R]	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	

CALIBRATION AND CALIBRATION CHECK INFORMATION (Continued)							
Time	Type of Calibration or Calibration Check	Calibration Standard		Instrument Response		Response within Tolerances (circle one)	Comments
		Type	Conc.	w/o Dilution Probe	w/ 10-to-1 Dilution Probe		
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Mid-Screening Recalibration*	Free Air	0.0 ppmv		N/A	Yes / No	
		Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	1,000 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	
	Single-Point Bump Calibration Check*	Isobutylene	50.0 ppmv		N/A	Yes / No	
		Isobutylene	5,000 ppmv	N/A		Yes / No	

Notes: 1. R = Required 2. * = If necessary 3. ppmv = parts per million by volume

Form Revision 0

FIXED GASES AND SOIL VAPOR CONCENTRATION FIELD SCREENING DATA

PROJECT INFORMATION		GENERAL INSTRUMENT INFORMATION		SCREENER INFORMATION	
Project Name:		Fixed Gases:		Screener's Name:	
Project Number:		PID (Low Level Confirmation):		Screener's Title:	
Task Name:		PID (Low-High Level):		Assistant's Name:	
Task/Project Manager:		FID (Low-High Level):		Assistant's Title:	

FIELD SCREENING RESULTS

WELL ID or SAMPLE ID	SAMPLE DATE	SAMPLE TIME (24-Hour)	SCREENING DATE	SCREENING TIME (24-Hour)	Observed Field Screening Values[1], Units, and Dilution Values[2]									Corrected Value[3]		COMMENTS
					O_2 (%)	CO_2 (%)	% LEL[4] (%)	PID	PID UNITS (circle one)	PID Dilution Value[2] (circle one)	FID	FID UNITS (circle one)	FID Dilution Value[2] (circle one)	PID (ppmv)	FID (ppmv)	
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			

Field Screening Data Form.xls

Page _____ of _____

FIELD SCREENING RESULTS																
WELL ID or SAMPLE ID	SAMPLE DATE	SAMPLE TIME (24-Hour)	SCREENING DATE	SCREENING TIME (24-Hour)	Observed Field Screening Values[1], Units, and Dilution Values[2]									Corrected Value[3]		COMMENTS
					O_2 (%)	CO_2 (%)	% LEL[4] (%)	PID	PID UNITS (circle one)	PID Dilution Value[2] (circle one)	FID	FID UNITS (circle one)	FID Dilution Value[2] (circle one)	PID (ppmv)	FID (ppmv)	
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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FIELD SCREENING RESULTS

WELL ID or SAMPLE ID	SAMPLE DATE	SAMPLE TIME (24-Hour)	SCREENING DATE	SCREENING TIME (24-Hour)	Observed Field Screening Values[1], Units, and Dilution Values[2]									Corrected Value[3]		COMMENTS
					O_2 (%)	CO_2 (%)	% LEL[4] (%)	PID	PID UNITS (circle one)	PID Dilution Value[2] (circle one)	FID	FID UNITS (circle one)	FID Dilution Value[2] (circle one)	PID (ppmv)	FID (ppmv)	
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
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									ppbv ppmv %	1 10		ppmv %	1 10 25 50			
									ppbv ppmv %	1 10		ppmv %	1 10 25 50			

Notes: [1] = As observed on the instrument's display; If flame-out occurs, record "FO" as the default value.
[2] = Dilutions Values (Dilution Probe Specific): No Dilution Probe Used - Circle "1"; 10-to-1 Dilution Probe Used - Circle "10"; 25-to-1 Dilution Probe Used - Circle "25"; 50-to-1 Dilution Probe Used - Circle "50"
[3] = Calculated based on the units and dilution value or, in the case of a flame-out when sufficient oxygen is present, the upper dynamic range of the instrument multiplied by the dilution value.
[4] = If required by project or task
E = Estimated Value: Corrected value exceeds the upper dynamic range of the instrument or flame-out due to concentrations above the instruments range occurred.
ppbv = Parts per billion volume
ppmv = Parts per million volume
% = Percent by volume
N/A = Not Applicable
FO = Instrument Flame Out (FID Only)

SOIL VAPOR SAMPLING FIELD FORM

PROJECT INFORMATION

Site: _____ Client: _____

Project Number: _____ Task #: _____ Date of Sampling: _____

Field Personnel: _____

SUMMA CANISTER SAMPLE INFORMATION

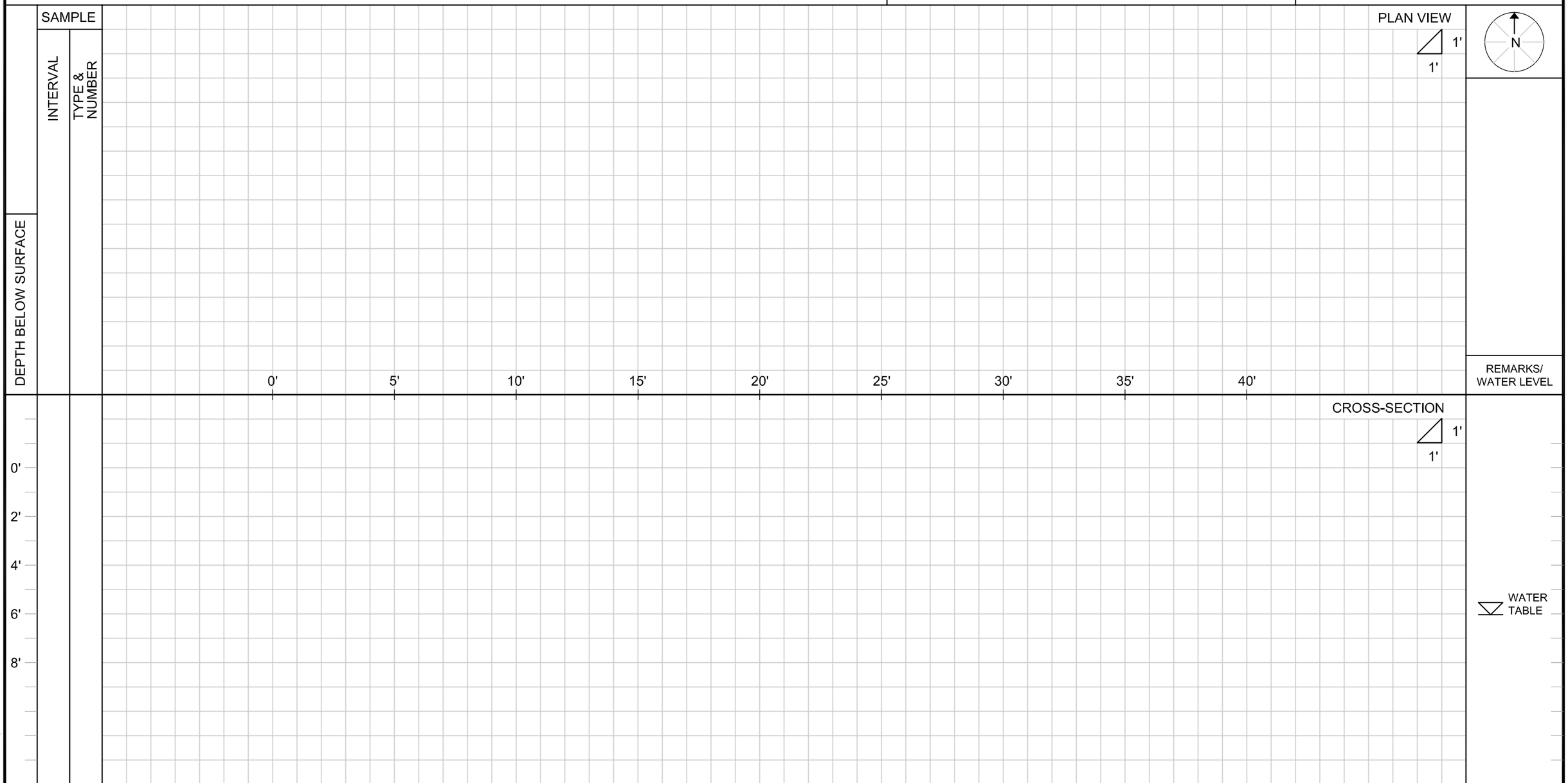
Probe / Well / Location ID	Sample ID	Canister ID Number	Flow Regulator ID Number	Canister Vacuum (In. Hg)		Sample Time (24-Hour)		Comments
				Initial	Final	Start	Finish	

NOTES

ABBREVIATIONS

In. Hg - Inches of Mercury
NA - Not Applicable
NM - Not Measured

PROJECT NAME:	PROJECT NO.:	LOGGER:	COMMENTS:	TEST PIT NO.: SHEET OF
LOCATION:				DATE EXCAVATED:
ELEVATION:	EXCAVATION METHOD:	CONTRACTOR:		
APPROXIMATE DIMENSIONS: LENGTH:	WIDTH:	DEPTH:		



ADDITIONAL COMMENTS:

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WELL DEVELOPMENT AND GROUNDWATER SAMPLING FIELD FORM

PROJECT INFORMATION

Site: _____ Client: _____

Project Number: _____ Task #: _____ Start Date: _____ Time: _____

Field Personnel: _____ Finish Date: _____ Time: _____

WELL INFORMATION

Well ID: _____

Casing ID: _____ Inches

Screen Interval: _____

Borehole Diameter: _____ Inches

Filter Pack Interval: _____

EVENT TYPE

☐ Well Development

☐ Low-Flow / Low-Stress Sampling

☐ Well Volume Approach Sampling

☐ Other (Specify below)

_____

PURGE INFORMATION

Purge Method: ☐ Bailer ☐ Pump

Bailer Type: _____

Pump Type and Serial #: _____

Tube/Pump Intake Depth: _____

Stabilized Pumping Rate: _____

DEPTH MEASUREMENTS

	INITIAL		FINAL	
	Depth (_____)	Time (24-Hour)	Depth (_____)	Time (24-Hour)
LNAPL				
Groundwater				
DNAPL				
Casing Base				

VOLUME CALCULATION AND PRODUCTION INFORMATION

Volume Calculation Type: ☐ Well Casing ☐ Borehole

Volume Per Foot: _____

Standing Water Column: _____ feet

1 Well Volume: _____ Gallons 3 Well Volumes: _____ Gallons

5 Well Volumes: _____ Gallons 10 Well Volumes: _____ Gallons

Total Volumes Produced: _____ Gallons

Well Purged Dry? ☐ Yes ☐ No

Water Level Serial #: _____

Water Quality Probe Type and Serial # _____

WATER QUALITY INDICATOR PARAMETERS

Sampling Stage (pre, purge, etc.)	Time (24-Hour)	Volume Removed (_____)	Depth to Water (_____)	Drawdown (Feet)	Temp (_____)	pH (Std. Units)	SEC or Cond. (_____)	Dissolved Oxygen (_____)	Turbidity (_____)	ORP (_____)	Visual Clarity

NOTES

ABBREVIATIONS

Cond. - Actual Conductivity
FT BTOC - Feet Below Top of Casing
NA - Not Applicable
NM - Not Measured
ORP - Oxidation-Reduction Potential
SEC - Specific Electrical Conductance
Std. Units - Standard Units
Temp - Temperature

WELL DEVELOPMENT AND GROUNDWATER SAMPLING FIELD FORM

PROJECT INFORMATION

Site: _____ Client: _____

Project Number: _____ Task #: _____ Start Date: _____ Time: _____

Field Personnel: _____ Finish Date: _____ Time: _____

WELL INFORMATION

Well ID: _____

Casing ID: _____ inches

EVENT TYPE

☐ Well Development ☐ Low-Flow / Low Stress Sampling

☐ Well Volume Approach Sampling ☐ Other (Specify): _____

WATER QUALITY INDICATOR PARAMETERS (continued)

Sampling Stage pre, purge, etc.	Time (24-Hour)	Volume Removed (_____)	Depth to Water (_____)	Drawdown (Feet)	Temp. (_____)	pH (Std. Units)	SEC or Cond. (_____)	Dissolved Oxygen (_____)	Turbidity (_____)	ORP (_____)	Visual Clarity

NOTES (continued)

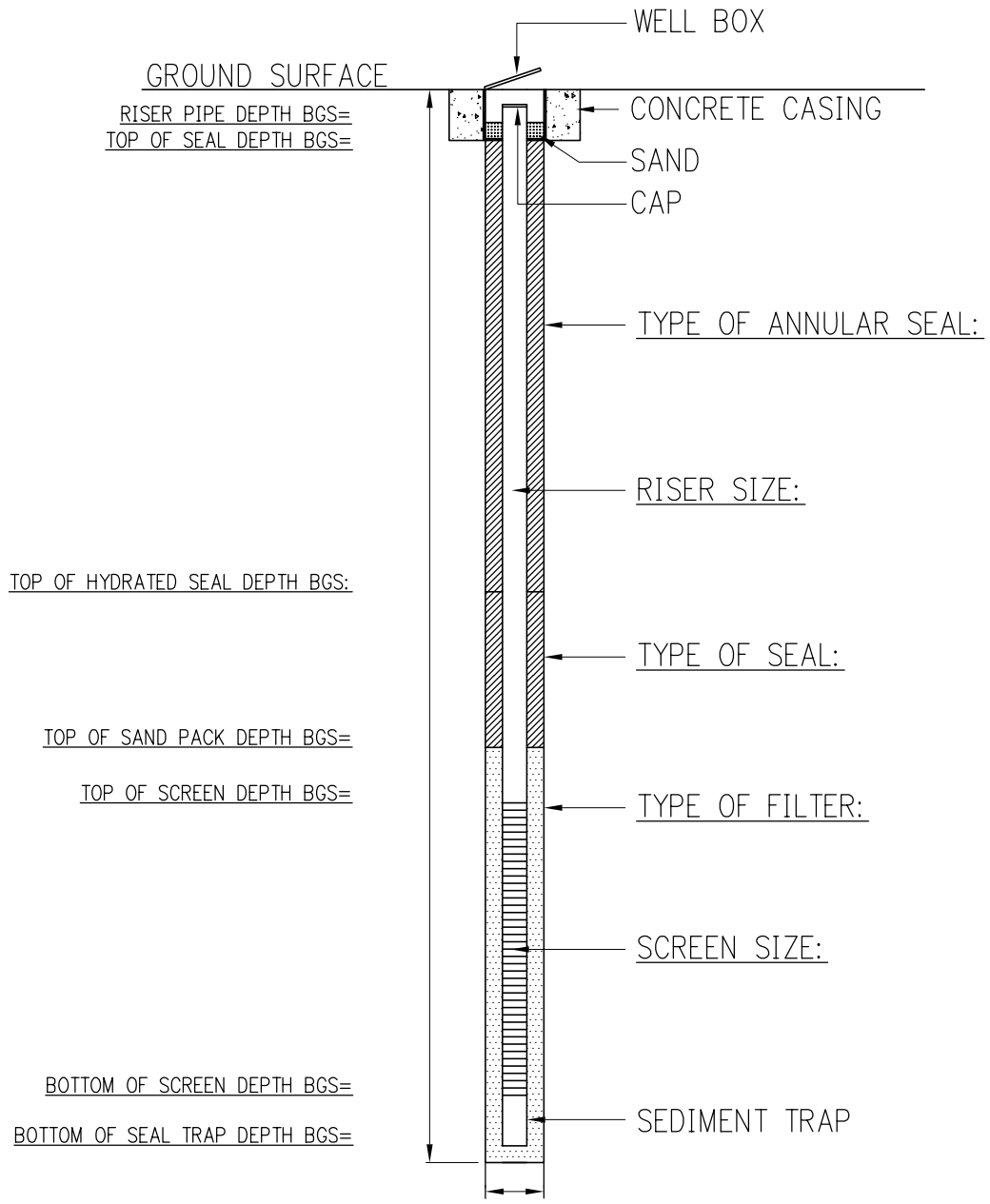
ABBREVIATIONS

Cond. - Actual Conductivity
FT BTOC - Feet Below Top of Casing
NA - Not Applicable
NM - Not Measured
ORP - Oxidation-Reduction Potential
SEC - Specific Electrical Conductance
Std. Units - Standard Units
Temp - Temperature

WELL INSTALLATION LOG

No. _____

CLIENT	COORDINATES N E	PROJECT	PROJECT NO.
PROJECT LOCATION		TOP OF RISER ELEVATION (DATUM)	DATE
STRATUM MONITORED		LOGGED BY	
DRILLING COMPANY		APPROVED BY	



NOT TO SCALE

METHOD OF INSTALLATION:

REMARKS:

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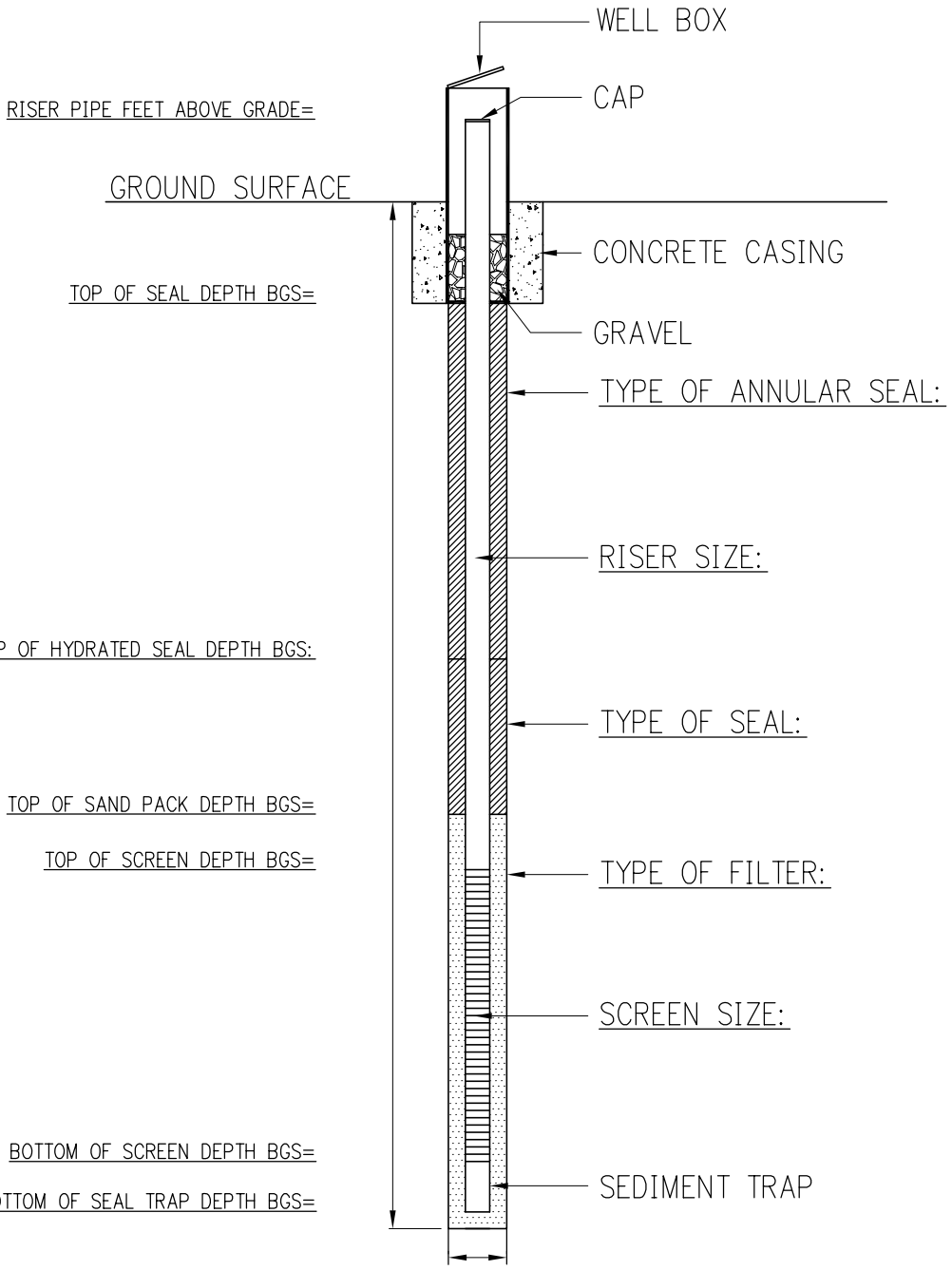
WELL INSTALLATION LOG

No. _____

CLIENT	COORDINATES N E	PROJECT	PROJECT NO.
PROJECT LOCATION		TOP OF RISER ELEVATION (DATUM)	DATE
STRATUM MONITORED		LOGGED BY	
DRILLING COMPANY		APPROVED BY	



NOT TO SCALE

METHOD OF INSTALLATION:

REMARKS:

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Number : _____ Weather : _____ Total Depth (ft) : _____ Sampling Type : _____

Start : _____ End : _____ Logger(s) : _____ Borehole Dia. : _____

Site : _____ comments : _____ Drilling Type : _____ Abandonment : _____

Project # : _____ Task # : _____

2. Depth (ft)	Symbol / Name		Percent, Number, Name		15. D 16. T 14. P	17. CONS	18. GRD	19-25. Particle Size (% and grn size)					26-27. ANG	STRC note thickness	CMT	HCl	Shape Enter %	Geologic Characteristic (sorting, HCl reaction, etc…)	Geologic Interpretation (till, outwash, overbank, etc…)	25. Odor	27-28. MST Min-Max	Additional Information
	1st	2nd	9-10. color	11-13. mottling				Trace <5%	Few 5-10%	Little 15-25%	Some 30-45%	Mostly 50-100%										

FIELD DATA AND OBSERVATIONS

PID, Pocket Penetrometer, Recovery, RQD, Sample Interval, etc…

EXAMPLE

Sample Interval	Recov. (ft)	Blow Counts	Pock. Pen	PID eV __	Field Observ
0-2	1.9	1/2/3/4	4.2	1.6	
2-4	1.3	1/2/3/4	5:1	0.2	
4-6	1.2	1/2/3/4	4.2	1.6	
6-8	0.9	2(50)	1:1	0.2	rough drilling, cobble in drill cuttings

Grn (Grain Size): **FS** (fine sand - ≥75 µm; <425 µm) ; **MS** (medium sand - ≥425 µm; <2 mm) ; **CS** (coarse sand - ≥2 mm; <4.75 mm) ; **FG** (fine gravel - ≥4.75 mm (0.9"); <3/4") ; **CG** (coarse gravel - ≥3/4"; <3") ; **CC** (cobbles - ≥3"; <12") ; **BB** (boulders - ≥12")

D (Dilatency): **N**(none) ; **S**(slow) ; **R**(rapid)

T (Toughness): **L**(low) : **M**(medium) ; **H**(high)

P (Plasticity): **N**(non) ; **L**(low) ; **M**(medium) ; **H**(high)

CONS (Consistency): VS(very soft) ; **S**(soft) ; **F**(firm) ; **H**(hard) ; **VH**(very hard) (fine grained material only)

GRD (Grading): **W**(well-graded) ; **P**(poorly-graded)

%: **T**(trace <5%) ; **F**(few 5-10%) ; **L**(little 15-25%) ; **S**(some 30-45%) ; **M**(mostly 50-100%)

ANG (Angularity): **A**(angular) ; **SA**(subangular) ; **SR**(subrounded) ; **R**(rounded)

CMT (Cementation): **W**(weak) ; **M**(moderate) ; **S**(strong)

Shape (gravel, cobbles, & boulders only): **F**(flat) ; **E**(elongated) ; **FE**(flat & elongated)

STRC (Structure): **S**(Stratified - >6 mm) ; **LA**(laminated - <6 mm) ; **F**(fissured) ; **SS**(slickensided) ; **B**(blocky) ; **LE**(lensed) ; **HO**(homogenous) ; **HE**(heterogenous)

HCl (Reaction with HCl): **N**(none) ; **W**(weak) ; **S**(strong)

PP Pocket Penetrometer (fine grained material only)

Core Collection and Processing Log

General Information

Project Name/Site : _____ Sampling Equipment: _____

Project # : _____ Coordinate System: _____

Task # : _____ Datum: _____

Date : _____ Weather: _____

Samplers : _____ River Section/DMU: _____

Sample Location	Time (military)	Water Elevation (ft)	Water Depth (ft)	Core Penetration (ft)	Sediment Recovered (ft)	% Recovery	Proposed Sample Location (Northing)	Proposed Sample Location (Easting)	Actual Sample Location (Northing)	Actual Sample Location (Easting)	Sample Description/Notes (Color, Texture, Odor, etc.)

Core Intervals (in)	Core Description	Date Processed	Sample Core Intervals (in) TOP	Sample Core Intervals (in) BOTTOM	COC Sample ID Number

Additional Comments: _____

n/a : Not Applicable

COC: Chain of Custody

Sampling/Processing Personnel Signature: _____

APPENDIX C

LIF FIELD OPERATING PROCEDURES

TarGOST® User's Guide

The Tar-specific Green Optical Screening Tool (TarGOST®) is a laser-induced fluorescence (LIF) screening tool that is specifically designed to detect non-aqueous phase liquid (NAPL) in the subsurface. It responds almost exclusively to the NAPL found at former manufactured gas plants (MGPs) and creosote/pentachlorophenol sites. It does this by sensing the fluorescence of polycyclic aromatic hydrocarbons (PAHs) found in MGP and creosote NAPLs. TarGOST is a modification of the Ultra-Violet Optical Screening Tool (UVOST™). Dakota developed the UVOST early in the 1990's with U.S. Air Force funding. The UVOST platform is a mature technology that has been applied at hundreds of petroleum, oil, and lubricant (POL) contaminated sites in the U.S., Europe, and Japan since 1994. TarGOST has been in commercial use since March 2003.

General TarGOST Principles

The TarGOST system is, in its simplest sense, a front-face fluorometer that is coupled via fiber optics to a sapphire-windowed probe that is shoved into the ground. A front-face fluorometer is a device that shines excitation light onto, and collects emission from, the same surface. This is different from standard fluorometers, which operate with the excitation and emission beams at 90°. The TarGOST system makes continuous front-face fluorescence measurements of the soil matrix as the windowed probe is pushed slowly down into the subsurface.

The fluorescence measurements are made 20 to 50 times each second (20 to 50 Hz). Each individual measurement begins with a pulse of laser excitation light being launched into one of two fiber optic cables that are strung through the drill/push rod string. As the rod is advanced into the subsurface, the very fast pulses of laser light (10 nanoseconds in duration) are directed out the sapphire window and onto the soil surface that is pressed very firmly against the outside of the window. The pulses of green light strike whatever is present just outside the surface of the window. Most of the laser light is simply reflected by the soil matrix. However, if oil-like material (OLM) or tar-like material (TLM) associated with former MGP processes is present, the PAHs that exist in these NAPLs absorb some of the light and are driven into an electronically excited state. When these PAHs eventually return to the ground state (this typically takes less than 10 ns), a portion of the PAHs emit red-shifted light (longer wavelength light than the excitation laser). Some of this fluorescence, along with a small portion of the reflected excitation laser light, are collected by a mirror and focused into the second collection fiber optic for return to the TarGOST instrument for detection.

The return light is directed into a spectrometer located inside the TarGOST system. A grating in the spectrometer disperses this light into a "rainbow" across the back plane of spectrometer. Four optical fibers are located in this backplane. One of the fibers collects a small portion of the relatively intense laser light (more about this laser scatter channel later) while the other three fibers capture bands of the fluorescence (~10nm wide) emitted by any PAHs present in the NAPL. The four fibers are different lengths so that each fiber delivers its 'packet' of fluorescence photons to the photomultiplier tube (PMT) at delayed time intervals. The result is a "train" of time delayed photon packets all arriving at the same PMT over a period of 300 nano-seconds (ns). The PMT is a device that converts photons into a current pulse. This current pulse

is wired into a fast digital storage oscilloscope where it is converted into a transient voltage signal, is digitized, and recorded. This digitized transient is called a waveform. The laser light that is being reflected from the soil matrix is monitored in the first channel (left-most) and the three fluorescence bands are observed in the three right-most channels.

Figure 1 illustrates waveforms that are typical of those generated with TarGOST. If the soil is clean of NAPL, the laser scatter channel (leftmost) is far more intense than the three fluorescence channels. The Clean Sand waveform in Figure 1 illustrates what clean (or very low NAPL) soil typically looks like on the TarGOST system. If NAPL is present, the fluorescence channels begin to grow in comparison to the laser channel. The 1000 ppm waveform in Figure 1 illustrates such a condition. The more coal tar present, the lower the scatter channel gets and the higher the three fluorescence channels get. Finally, with pure NAPL on the window, the greatest increase in the fluorescence channels is observed, along with maximum loss of signal in the laser reflectance channel – due to absorbance by the PAH-laden NAPL. The NAPL waveform in Figure 1 illustrates the waveform resulting from such a condition.

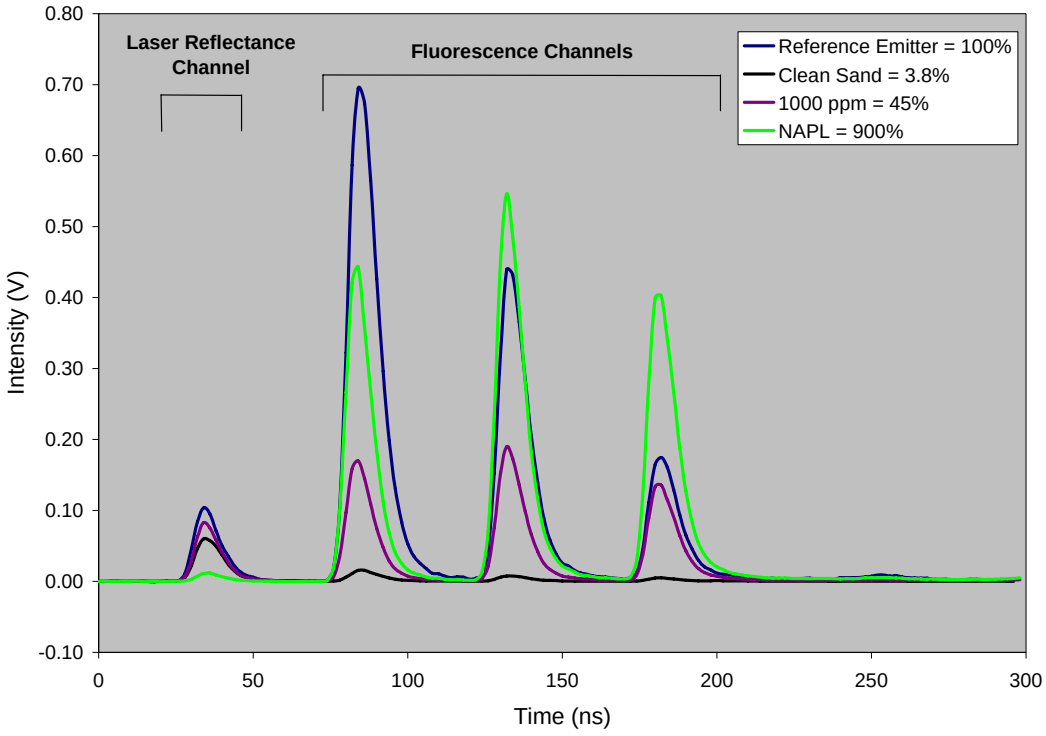

Figure 1. Example TarGOST waveforms.

Dakota Technologies, Inc. Fargo, ND 58102 Phone: 701-237-4908 Fax: 701-237-4926

Calibration/Normalization

The waveform shapes (the relative amount of signal in each channel and the decay time on the right side of each peak) tell us quite a bit about the qualitative nature of what's happening outside the window. But what interests people most is the **amount** of NAPL that is present vs. depth. We do this by portraying the fluorescence vs. depth (FVD) in a continuous log format. To accomplish this we must reduce the 2-D waveform to a single quantitative number. We also need to normalize for any energy drift of the laser and optical alignment changes, so it is necessary to calibrate the system prior to each sounding and plot the downhole data relative to a known fluorescence emitting reference (RE) material. The RE is a stable and known material that can be applied to the window and measured just prior to each sounding. The fluorescence of the downhole data, relative to this RE, is then plotted as a function of depth.

Figure 2 graphically illustrates the calibration procedure. The RE both reflects some of the laser light and fluoresces at levels that are in the same general range as soils that are moderately to heavily contaminated with MGP NAPL. The Reference Emitter waveform shown in Figure 1 is an actual RE waveform taken with the TarGOST. Notice that the RE fluoresces in the same general intensity range as the pure NAPL, but it also (by design) reflects a high degree of scatter due to its buff gray color and lack of photon absorbing PAHs. The RE is designed to do this so that both the system's fluorescence and scatter components can be properly gauged and recorded on the same scaling of the oscilloscope. Once the RE is measured, all subsequent downhole (or laboratory) measurements can be normalized by this RE waveform, providing an apples-to-apples presentation of the data regardless of laser energy drift or other changes that would cause a difference in raw signal amplitude over time. It is useful to think of the RE waveform as the equivalent of the single-point 100ppm isobutylene calibration used for hand-held photo-ionization detectors.

To calculate the %RE, the area under the three fluorescence channels of the waveform is determined. The fluorescence area is then divided by the area under the laser scatter channel. This is called scatter correction. This is necessary because at very high concentrations the fluorescence does not continue to scale with concentration. This is due to complicated processes such as energy transfer, photon cycling, and other phenomenon that "quench" the fluorescence in high NAPL concentration soils. The uncorrected TLM curve in Figure 3 illustrates the problem. The addition of more and more NAPL to a soil sample should result in increasing fluorescence, but for some reason it only increase up to a certain point, at which the fluorescence response flattens out, or even worse, begins to fall. This poor type of response is called non-monotonic behavior and is obviously undesirable behavior for a screening tool. The laser scatter correction system is designed to prevent this "roll-over" affect. The scatter correction keeps this from occurring at the high end of concentrations (where soil is heavily contaminated or even saturated with NAPL). The scatter-corrected curves in Figure 3 illustrate the desired effect of scatter correction.

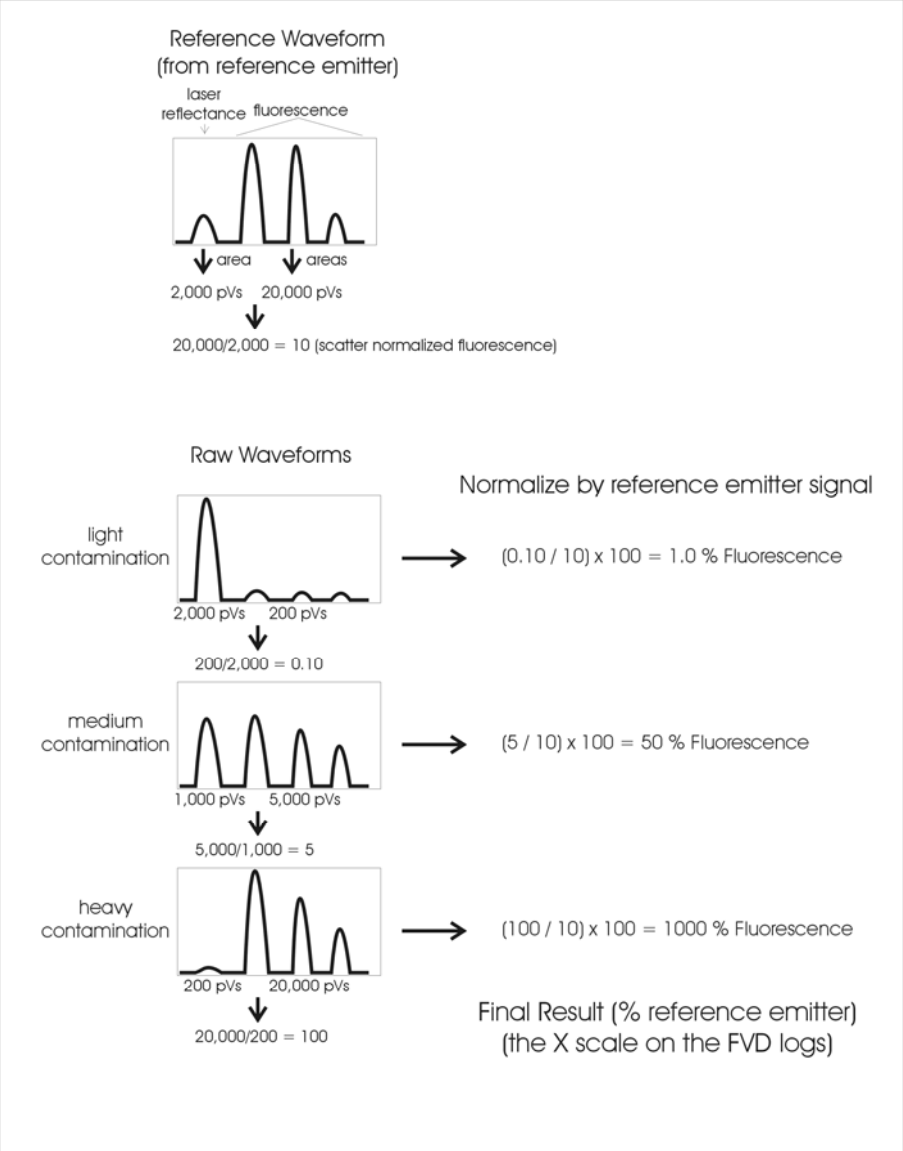

Figure 2. Single point RE calibration made prior to each TarGOST log.

The laser scatter intensity is relatively unaffected until NAPL concentrations reach the tens or hundreds of thousands PPM level, where the quenching (non-linearity of fluorescence response) is most pronounced. Laser scatter correction generally doesn't "kick in" until high concentrations are being measured, where fluorescence response flattens out or rolls over. In this way, the scatter corrected fluorescence readings scale relatively well across a wide range of concentrations, from the typical limit of detection (LOD) of 250-500 ppm, to the almost neat NAPL encountered in soil saturated with free product. Remember that TarGOST is designed to respond only to the NAPL impacted soils, not the PAHs attached in "dry" form to soot or dissolved phase PAHs. This makes it ideal for delineating source term areas of mobile MGP NAPL.

The scatter correction works well, but it isn't perfect. The TarGOST system is not an analytical instrument like a laboratory GC that sits in a clean, stable environment and only gets fed ultra-

clean matrix-isolated analytes. Instead, it is asked to respond faithfully to an analyte that exists in a thousand different forms in an endless number of different environments. Variation in optical

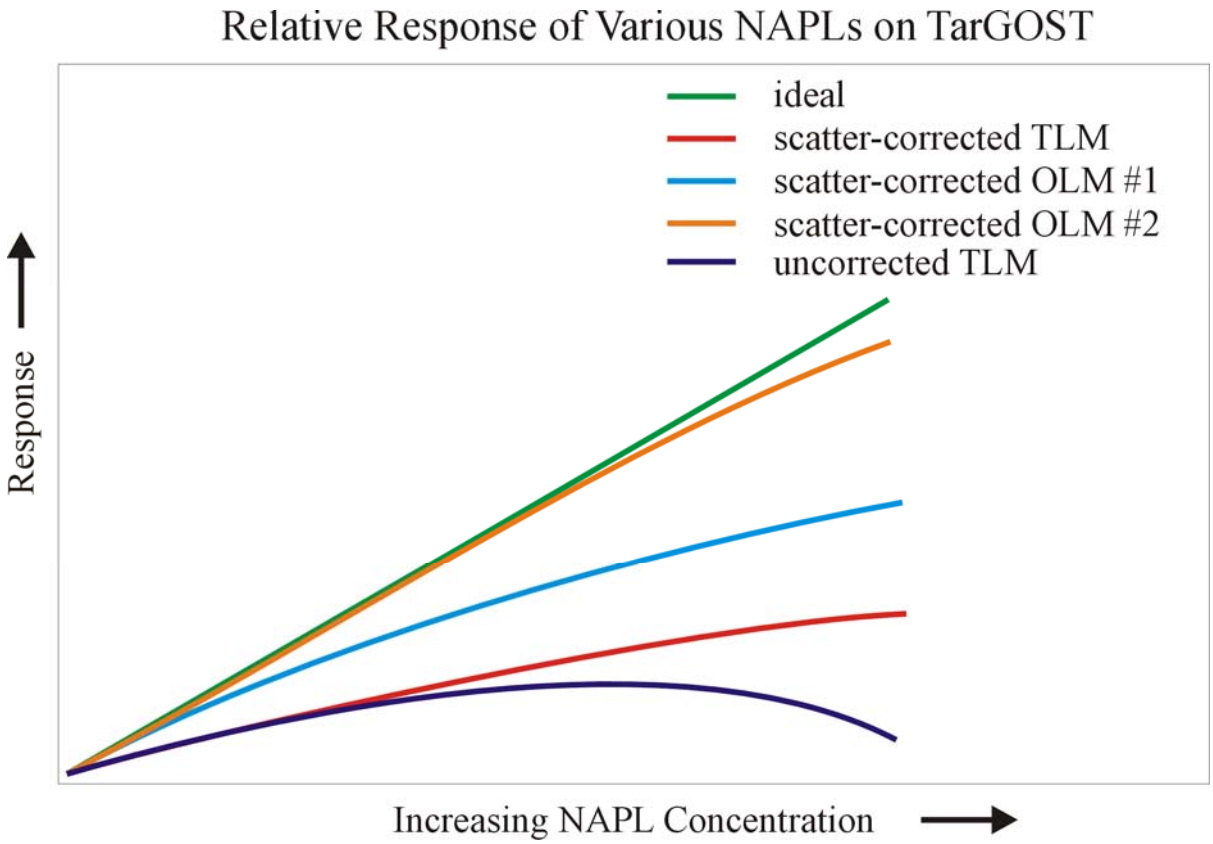

Figure 3. Variability of TarGOST response to NAPL products.

design (CPT vs. Geoprobe), mirror angle, and spectrometer settings can vary the amount of scatter present, especially at very high NAPL concentrations when the scatter is getting weak and difficult to measure relative to the much more intense fluorescence.

At high NAPL concentrations, even small variations in the laser scatter greatly influences the %RE number, especially when the laser scatter gets close to zero. For instance, let's imagine that with neat NAPL in front of the window, the fluorescence channels are averaging around 10,000 pico-Volt seconds (pVs) in area with each pulse of the laser. The laser scatter may be dancing around 400 and 800 pVs, because the scattered light is dim from being absorbed so highly by the PAHs. Now, even if the fluorescence stays almost exactly at 10,000 pVs every measurement, the relatively large variation in the tiny laser scatter that occurs will create a two or three-fold increase/decrease in %RE, even with the same NAPL sitting dead still on the window. That's why very high readings (500-1500%) often look unstable and jagged – because the laser scatter signal is so weak it "jitters" a lot compared to the fluorescence, causing large variations in %RE, even though the fluorescence portion of the waveform is relatively stable. For this reason, any wide swings in signals over 500% should "be taken with a grain of salt".

The TarGOST operators do their best to adjust the amount of launched laser light, the spectrometer position, and mirror angle in the probe to achieve a consistent waveform for the RE at each job site and strives to maintain the same optical arrangement and a consistent RE signal for the entire project. Even though there are small differences in the setup from location to location, the variations in NAPL viscosity, soil matrix, and signal magnitude can swing the signal up or down by a factor of two or three, which dwarfs the calibration differences.

The limitations in the current calibration technique can lead to the case of significant differences in the maximum signal generated by the same NAPL from one platform to another. For instance, even if the technician adjusts the system to achieve the exact same signal with RE on both a CPT and a Geoprobe platform, the same NAPL may yield 500% on one of the platforms and 1000% on the other. This is not typical but it can and does happen for reasons that aren't fully understood. Our goal is to stay consistent at a particular site so that the entire data set from that site can be viewed consistently. TarGOST data is relatively consistent and semi-quantitative across all the data generated **at one site** and **for a particular NAPL product,** but significant cross-platform or lab-to-field variations can and have taken place. While this may alarm users, and we're not happy with it, it's not as serious as it seems. As an example, let us imagine a site that is contaminated with a single origin homogeneous NAPL product. With TarGOST, 100% response does indeed represent approximately twice as much NAPL as a 50% response at that site. Even if the laser energy or optics alignments change, the RE will do a reasonable job of normalizing the log-to-log data variation for that site. Dakota is currently working on an improved system that will better normalize across all systems/platforms regardless of design or conditions.

Lab studies with MGP NAPL on moist Fisher® sea sand consistently demonstrate that TarGOST is capable of linear response vs. NAPL concentration, but some NAPLS are better behaved than others. Figure 4 is one example of the TarGOST response vs. MGP NAPL concentration on sand.

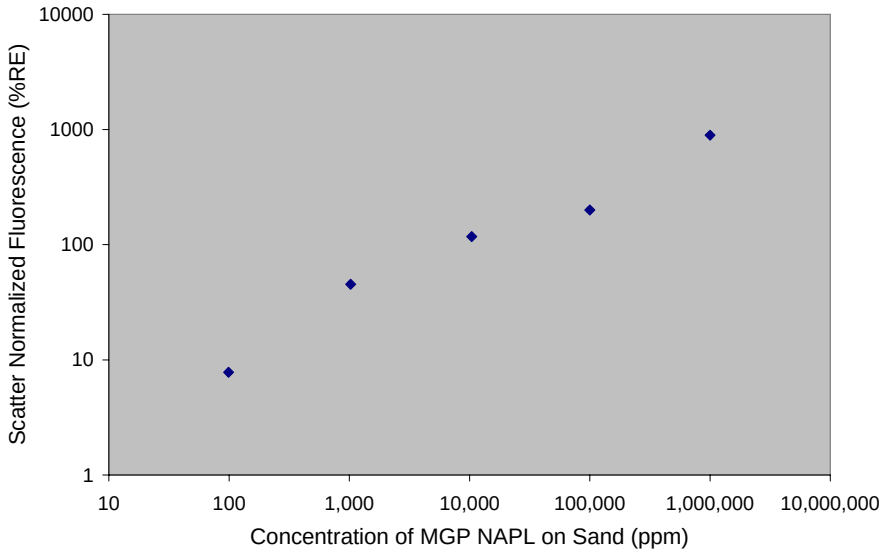

Figure 4. Calibration curve for MGP NAPL on Fisher Sea Sand

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NAPLs do vary in their ability to fluoresce, even NAPLs found at the same site. Figure 3 illustrates conceptually that TarGOST often responds with varying sensitivity (ΔTarGOST Signal/ΔNAPL Concentration) toward different NAPLs, depending on their origin and/or variances in the conditions under which they've been exposed in the decades they've spent in the subsurface. For instance, a more ashaltine TLM will typically fluoresce much less intensely than a runny, less viscous OLM. This may well be due to the relative abundance of solvent in one matrix vs. the other. The more solvent available (i.e. the less viscous the NAPL), the higher the likelihood of the PAHs being able to emit photons (fluoresce) before a non-radiative mechanism allows the PAH to come back down to the ground state without emitting a photon (quenching).

The preferential sensitivity of TarGOST toward the runnier (more mobile) OLMs is welcomed by most users, since TarGOST seems to accentuate the presence of the more mobile NAPLs. It is these more mobile NAPLs that are of the highest regulatory/compliance concern. There is an abundance of anecdotal evidence that suggests that some NAPLs may fractionate in the subsurface into OLM and TLM or even DNAPL and LNAPL. Dakota has participated in a number of investigations where a single NAPL body seems to have 'split' into two distinct NAPLS, with both NAPLs having similar but distinct waveform shapes as we moved away from the suspected release point and they appear to form two separate horizons (a "high" and "low" layer). Although there has been plenty of speculation, the exact mechanism for this phenomenon (if it actually occurs) is not known.

As previously described, TarGOST uses a green laser to excite the larger (4 -5 rings and higher) PAHs that exist almost exclusively in NAPL form, as opposed to smaller (2-3 ring) PAHs that can more readily partition into the groundwater due to their much higher solubilities in water. UVOST on the other hand employs ultra-violet (UV) light which can and does excite the smaller 2-3 ring aqueous phase PAHs and therefore detects dissolved phase PAHs such as naphthalenes in the groundwater. When this behavior is combined with UVOST's non-monotonic response for many NAPLs, extremely complicated logs are generated that need to be computer analyzed to separate the NAPL fluorescence contribution from that of the dissolved phase. The dissolved phase signals can even surpass NAPL signals, making confident NAPL delineation almost impossible at many sites. This is especially true for those sites with sand/gravel, where pockets of NAPL are perched in or amongst slow-moving or stagnant groundwater.

It should also be mentioned that TarGOST was designed to exclusively detect heavy PAH NAPLs. It has, by design, a very limited, if any, response to lighter POLs. For instance, fresh diesel applied to the window will not elicit even a small response from the TarGOST. However, if the diesel has co-mingled with coal tar, the mixture will fluoresce brightly and TarGOST will respond well.

To better appreciate the qualitative information that TarGOST provides, the FVD logs are color-coded by "filling in" the FVD's x-axis (%RE) with colors generated from the waveform at each and every depth. The color is determined by "mixing" the amount of red, green, and blue (RGB) channels and applying the resulting color to the area under the curve on the FVD. This makes the interpretation of the logs easier to see "at-a-glance" as opposed to relying solely on the few selected waveforms to understand the qualitative nature of the data vs. depth. Color-coding alerts the observer to shifts in NAPL types and can also help identify weak interfering

compounds like calcium rich (crushed limestone) soils and rotting wood/vegetation, both of which can sometimes (rarely) be mistaken for MGP waste.

Figure 5 shows the resulting colors for differing amounts of signal in each channel of the waveforms. Clean soil shows up blue (nearly 100% laser scatter), low-to-medium contamination often shows up orange or maroon (mostly red with some blue and green), and highly contaminated soils or neat NAPL typically shows up yellow (nearly all red and green with very little blue makes yellow). The color is simply another way of representing the information contained in the associated waveforms (shown in sub-panels at right in the figure). Just think of the color-coding as mixing paints in amounts equal to that contained under each associated red, green, and blue channel of the waveform. The standard for TarGOST is to use blue, red, and green in channels 1, 2, and 3 - leaving the fourth channel unused. The fourth channel was chosen to be the non-contributor to the color scheme because it varies the least in intensity across differing classes of NAPL.

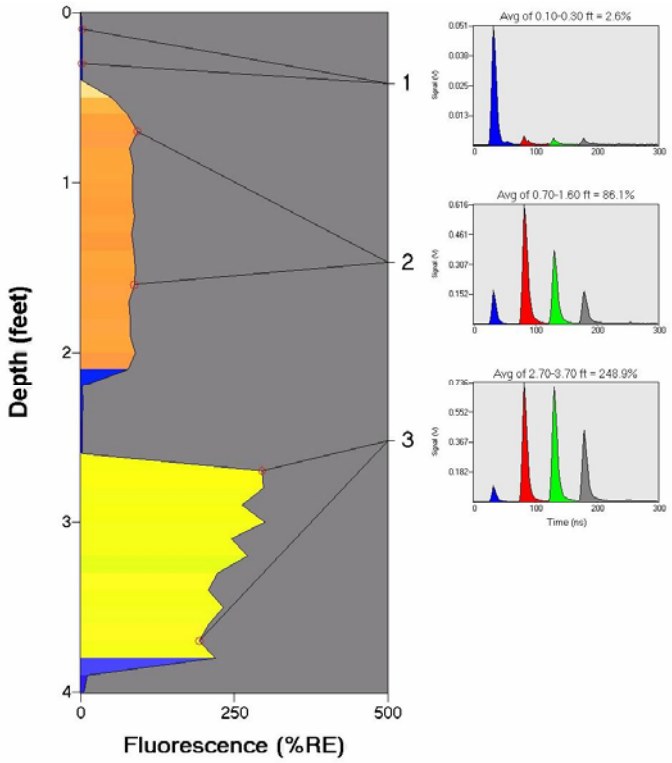

Figure 5. Example waveforms showing colors generated from RGB channel ratios.

The list below summarizes some of what we've learned in this section.

- TarGOST specifically targets the PAHs found in former MGP and creosote NAPLs
- TarGOST does detect staining and residual levels of NAPL as well as free phase
- TarGOST is "blind" to aqueous phase PAHs
- TarGOST is not able to reliably detect "dry" PAHs that are sorbed to soot, wood chips, and ash. They can generate a signal but it is often weak and not easily teased out of the background. Many times we're left wondering whether a small signal is caused by very

high concentrations of “dry” PAHs on purifier chips or ash/soot or very low (100s of ppm) residual NAPL levels.

- TarGOST’s typical lab-determined LOD for NAPL on site soil (or Fisher sea sand) is 250-500 ppm (weight of NAPL/weight of soil matrix). Note that this is not the same as weight of Total PAHs /weight of soil matrix, since not all of a NPAL is PAHs
- TarGOST has, on rare occasions, responded to mineral or plant interference enough to be a nuisance. One incident involved crushed limestone gravel fill while another involved buried rotting wood/brush debris (the result of major flooding on a gravelly river)
- TarGOST has not been observed to significantly respond to peat material (but this does not guarantee it won’t on some future occasion)
- TarGOST does not respond to typical lighter end fuels like gasoline, kerosene, or diesel – unless they contain MGP waste or creosote that they are co-mingled with
- TarGOST is single-point calibrated with a reference emitter (RE) immediately prior to each sounding and the results are always plotted relative to RE in percent
- TarGOST calibration/setup isn’t perfect and the response for an identical NAPL can vary with optical platform (CPT vs. Geoprobe) and from lab to field. However, once set up on site, the response remains stable over time and from log-to-log.
- NAPLs can vary greatly in their fluorescence response – even those found on the same site.
- Thinner, less viscous NPALS typically fluoresce much more than the more viscous TLMs. Asphalt-like TLMS which are solid/plastic fluoresce very poorly.
- Scatter-correction is applied to TarGOST data to reduce/eliminate “response rollover” at high concentrations
- Color-coding is deduced from the first 3 waveform channel areas and provides “at-a-glance” recognition of waveform consistency or changes
- The waveforms contain both quantitative and qualitative information

On-site TarGOST Fundamentals

So now that we understand the fundamentals of how TarGOST works, let’s examine the logging procedure at the site. When the system first arrives on site, it is powered up and tested for proper function. If it is in Dakota’s Geoprobe, the TarGOST is simply powered up and we’re ready to begin probing after proper warm-up. If CPT deployment is involved, the TarGOST system is integrated into the CPT truck and proper data flow connections are made (about a 2 hour procedure). Once the system is warmed up and tested for proper function, the actual logging can begin.

The delivery platform (CPT, Geoprobe truck, or track-rig) is positioned over the flag/mark as directed by the controlling geologist/consultant. Clients typically start out in an area where NAPL is known to (or strongly believed to) exist. Pushing in “the heart” of the source term at the start gives everyone involved a feel for how well the NAPL is going to respond to TarGOST delineation. From there, the effort often moves out and away from the “hot zone” toward the edges, with hopes of bounding the extent of the NAPL source term.

TarGOST productivity can range anywhere from 200 to over 500 ft/day. If the pushes are fairly deep (>30 ft), and the obstructions or rubble are minimal, then the average is on the higher end

because we spend a lot more time actually probing, not moving around from location to location and/or trying multiple times to get holes started through rubble. On jobs with lots of shallow holes and/or numerous subsurface obstructions, like brick/rubble from previous demolitions, the production obviously slows down. This is due to spending lots of time making attempts to "get a straight hole going" or from break-offs and the subsequent repair they entail. We typically can achieve between 10 and 20 locations a day, again depending on the site conditions.

Buried utility clearance is often an overlooked issue, until the first day of the project when everyone realizes we can't probe without it. Weeks or months of planning are often stalled the first day due to improper preparations with regard to utility clearance. The TarGOST crew has been instructed NOT TO PROCEED if there is even a remote chance that the proper precautions have not been made to clear the location for underground utilities.

Once the location has been cleared for utilities, the RE material is put on the cleaned window, any necessary tweaks are made to the TarGOST, and an RE waveform is acquired. The probe is then positioned in the push platform for advancement into the soil. In the case of percussion or "jack-hammering" delivery such as Dakota's Geoprobe, the window is approximately 8 inches above the tip of the probe. In the case of cone-penetrometer test (CPT) delivery, the window is approximately 16 inches above the tip of the probe. When using Geoprobe delivery, the log is initiated when the window is at the ground surface. In CPT delivery, the log is initialized when the CPT tip is in contact with the ground. In both cases, the software automatically corrects for the window position and all logs are depth correct.

A unique name for the current log location is entered into the control computer and logging is started (probe advance begins). As the probe is pushed into the ground (at ~2cm/sec) the laser fires continuously, generating waveform after waveform on the detection system oscilloscope as the probe advances. We don't store every waveform that the oscilloscope records. We instead average the waveforms over every 1-2 inches, depending on the probe speed and laser repetition rate. The averaged waveforms are downloaded from the oscilloscope every second or two by the control software. These waveforms are immediately 'tagged' with the current depth, which is constantly being sent to the TarGOST system by depth monitoring systems built into the Geoprobe or CPT truck. All the averaged waveforms from the logging event are stored to the hard-drive for later viewing and presentation if necessary or desired. The scatter and fluorescence areas are calculated and these are normalized to the RE waveform's areas. The fluorescence response is plotted vs. depth in real time as the probe is advanced. Logging continues until "refusal" is met due to bedrock or very tight sands/gravels, or the client wishes to terminate.

The technician then uses the TarGOST software to highlight the waveforms at "depths of interest" for display in the print out. The waveforms are located in panel plots at the right of the FVD log to guide the viewer's interpretation of the log. These waveforms contain the qualitative information and are often chosen from depths with peak signal, signal changes, or other zones of interest along the log's Y depth axis. The technician immediately prints a hard copy, which is usually printed out before the probe is completely retrieved from the subsurface. The technician also saves an electronic image of the printed log in JPG format. At the end of the project the

technician typically writes all the data and image logs to a CD, which is given to the lead geologist before departure.

Once the rods are all up and out of the hole, the hole is grouted (if necessary) and the probe tip and sapphire window is wiped clean in preparation for the next RE calibration. Time and money can often be saved by hiring a second crew/rig to grout the holes, instead of relying on the more expensive TarGOST system to do an otherwise routine task such as grouting. The next location is chosen and the procedure is repeated. The site investigation is often started with a grid or transect in mind, but it is common for the controlling geologist to modify the initially proposed investigation plan due to unforeseen "dirty" or "clean" zones encountered during the project. It is actually rare for the original transect or grid pattern to remain unchanged during the entire investigation, since the TarGOST regularly reveals previously unknown conditions at the site, including NAPL-free areas where significant NAPL was expected.

We recommend that the client conduct validation/confirmation sampling to bolster confidence in the body of evidence generated with TarGOST. Validation sampling of 10% of the TarGOST locations seems to be the most common co-sampling effort. Once the client gets familiar with TarGOST and becomes more comfortable with interpreting the results, they typically only sample where results are confusing or fly in the face of previous site understanding/information.

It is recommended that the client also conduct a few side-by-side tests of TarGOST for site heterogeneity assessment. Some sites yield nearly identical TarGOST logs when they are conducted a few feet apart because the NAPL is lying in well-behaved, homogeneously distributed layers. Other sites have extremely complex and heterogeneous NAPL distribution and yield side-by-side TarGOST logs with significant differences. In these conditions it is certainly unfair to conduct co-sampling efforts for TarGOST validation and expect TarGOST to "match" the traditional sampling results. In this case, even though the NAPL is scattered here and there, the validation hole is considered to be "right" and the TarGOST log, if not matching, is considered "wrong". In such heterogeneous environments even two side-by-side traditional sampling efforts might not come close to matching each other. So which one of the two traditional sampling locations is "right" and which one is "wrong" in this instance? Clearly neither is right or wrong, the site NAPL is simply heterogeneously distributed. Please keep this in mind when validation sampling against TarGOST as well.

The list below summarizes key aspects of deploying TarGOST at a former MGP or creosote site.

- TarGOST production averages between 10 and 20 locations/day and 200-500 ft/day, depending to large degree on subsurface conditions and difficulty in positioning the push platform over the desired location
- Proper utility clearance is the most important step in assuring a timely start and to prevent delays
- Start pushing in the "heart" of the source term to get a feel for the responsiveness of the TarGOST to your particular site's NAPL, then work your way out to find the edges and bound the source term NAPL
- Be prepared to adapt your transect and grid to ever-changing site model as TarGOST logs are reviewed

- On large-scale projects, consider hiring a second crew to pre-probe and/or grout with a small Geoprobe or drill rig if regulations/conditions warrant. While we don't mind doing the pre-probing or grouting ourselves, we want to spend the majority of our time doing what it is we're getting paid to do – delineate the site's NAPL
- Can TarGOST tell the difference between residual and free phase NAPL? The answer is clearly "No". There is no exact concentration where all NAPLs make a magical transition from "heavy residual" to "saturated or free-phase". Likewise, there is no set %RE that we can cite as being representative of saturated or free phase NAPL, since the response is continuous with concentration. With that said, it is certainly possible to determine a certain cutoff or signal range that is representative of the residual to free-phase transition for your site. For instance, let's say that after examining all the TarGOST logs and comparing them to previous efforts and the validation sampling, the geologist notes that free phase existed at depths/locations where the TarGOST logs exceeded 50%. It's certainly reasonable then to make the assertion that the 50% RE level is a general cutoff for the absence/presence of free-phase. Just remember that the entire body of evidence for any particular site should be used to come up with your %RE number

If you have any questions regarding your past or future project, feel free to call or write to your TarGOST operator or Randy St. Germain at stgermain@dakotatechnologies.com.

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UVOST™ USER'S GUIDE

Note: Dakota Technologies' ultra-violet wavelength laser-induced fluorescence tool is now named Ultra-Violet Optical Screening Tool (**UVOST™**). UVOST detects typical bulk petroleum, fuels, and light oils while TarGOST® is specifically designed to respond to coal tars and creosotes.

LASER-INDUCED FLUORESCENCE (LIF)

Fluorescence spectroscopy is one of the most widely applied spectroscopic techniques in use today. It is, by nature, a fast, sensitive and typically reversible process that makes it ideal for incorporation into a continuous screening technique that uses an optically transparent window as the conduit between the sensor and the analyte. Luminescence is the emission of light from any substance that returns to the ground state after being excited into an electronically excited state. If the bulk of the molecules emit their photons in less than a microsecond the emission is referred to as fluorescence. Emissions that take longer than this are called phosphorescence.

Fluorescence is typically observed in molecules that have an aromatic structure. One class of aromatics is the PAH found in quantity in typical petroleum products. The PAHs found in coal tars, creosotes and even sediments are also fluorescent, but they fluoresce much less efficiently than PAHs dissolved in more solvent-rich environments, such as the aliphatic body that makes up the bulk of fuels/petroleums. Dakota Technologies (Dakota) has observed that the less solvent available, the less efficiently the PAHs fluoresce. The PAHs continue to absorb the excitation light, but there is a much higher likelihood of the PAHs finding a non-radiative mechanism with which to shed the additional energy they picked up during the absorption of the excitation photon(s). In spite of this, the PAHs in sediments can still be coaxed into fluorescing well enough to allow in-situ laser-induced fluorescence screening via a sapphire-windowed probe.

A plot of the relative distribution of the different colors (or energies) of the photons being emitted by an excited sample of PAH is called the spectrum (or spectra when referring to more than one). Figure 1 illustrates the concept of PAH absorbance and fluorescence spectra. The spectra of individual PAH species (such as naphthalene and anthracene) can contain enough structure (peaks and valleys) to be identified in simple mixtures in the lab. The fluorescence of PAHs in sediments however, is originating from such a wide variety and concentrations of PAHs and differing local environments (dissolved phase, sorbed to particles, microcrystals, etc.) that the resulting spectra are very broad and contain very little "structure" that one might use to determine which individual PAHs are responsible for the fluorescence. The spectra do shift enough to recognize that the distribution of species or environments are changing, but individual speciation is impossible.

Another property of fluorescence that can be measured is the varying amount of time it takes for the molecules to emit the photons after exposure to a pulsed excitation source, such as a laser is illustrated in Figure 2. If we use a time sensitive detector to observe the number of photons being emitted over time, we can derive more information about the nature of the fluorophores and their environment. The different PAHs and the differing environments that exist in

sediments all combine to change the decay times observed. This information is readily obtained when using a pulsed source such as the laser we used in this application. UVOST allows us to investigate not only what colors are being emitted, but also how long it takes for the excited population of PAHs to emit the fluorescence photons. We use a patented method of combining the photons from four regions of the emission spectrum optically collected over 20 nm wide sections of the emission spectra at 340, 390, 440, and 490 nm.

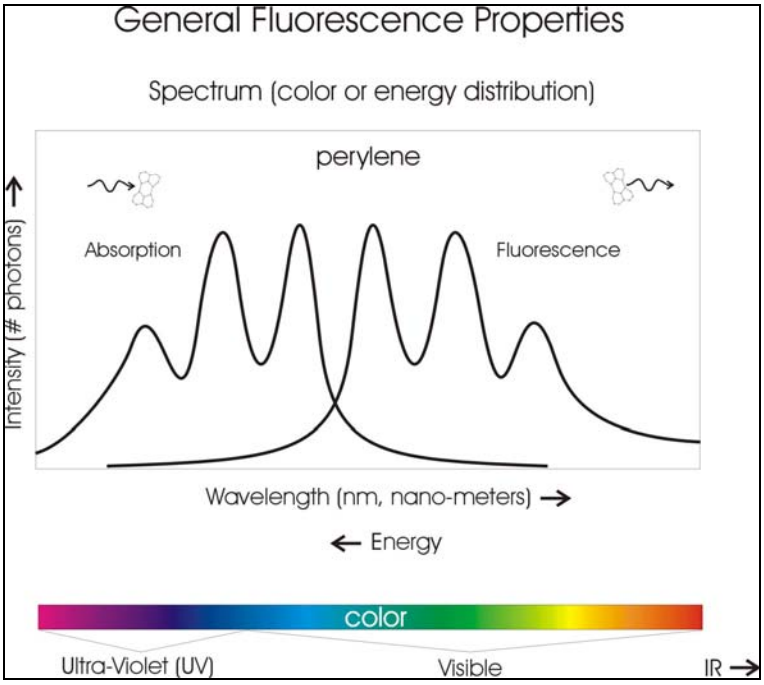

Figure 1. Spectral property of fluorescence

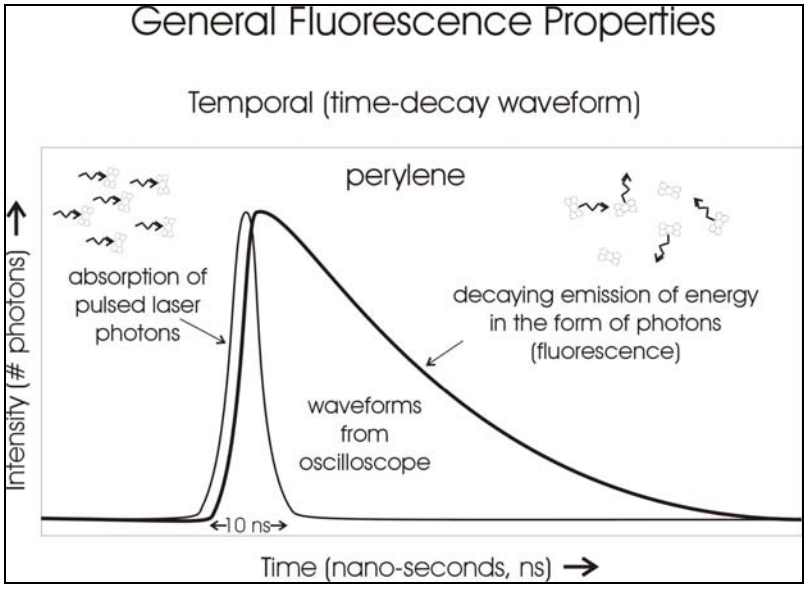

Figure2. Temporal property of fluorescence

These four "channels" are delayed in time through successively longer fiber optic delay lines and eventually arrive at the detector (photomultiplier tube or PMT). The resulting waveform is a unique measurement of both the spectral and temporal components of the fluorescence. This allows us to simultaneously observe the spectral and temporal qualities of the fluorescence. This technique is described in detail later in this report. It is these multi-wavelength waveforms, measured continuously and stored vs. depth, that ultimately serve as our indicator of PAH concentration vs. depth in the sediment.

Interferences

Nature has co-deposited a myriad of additional fluorescent materials in sediments that will also absorb the laser light and fluoresce intensely enough to complicate the measurement of the PAH fluorescence. Example materials include minerals such as calcites and a variety of biological materials. Both living organisms and their associated breakdown products (humic and fulvic acids) fluoresce well enough to interfere with the observation of the fluorescence of the target PAHs. This fluorescence, along with scattered excitation laser light and Raman light generated throughout the optical train (fiber optics) will ultimately make it back to the detector, mixed in with true PAH fluorescence, and must be accounted for in some fashion. Throughout this document we will refer to all these sources of non-PAH emitted photons as "background" fluorescence, even though the true source might well be non-fluorescent (scatter) in nature.

UNDERSTANDING UVOST FLUORESCENCE WAVEFORMS

Spectroscopic techniques involve probing the target matrix with light and learning about the contents of that matrix by analyzing the light that is emitted or absorbed by the target matrix. For screening tools it is crucial to glean as much information from this light as one can in as little time as possible. UVOST accomplishes this task in a novel fashion. The fluorescence data from UVOST is deceptively simple. There is a lot more going on in a UVOST waveform than one would imagine at first glance. It is actually a two-dimensional data set that contains three-dimensional fluorescence information. To complicate this, some of the information is overlapping. A full description of the multi-wavelength waveform data follows in order to give the reader an understanding of the data acquired during this study.

PAH time decay waveforms

Each type of PAH molecule (such as phenanthrene, naphthalene, or anthracene) emits fluorescence over a unique time period after being excited by a pulsed excitation source such as the laser used in UVOST. The emission starts out at maximum intensity, and then decays away at a rate unique to each type of PAH. The number of rings, the bonding between them, the amount of substitution on the rings, and other structural features of the molecule determine, to a great extent, the decay rate exhibited by a particular PAH. One class of molecule, the PCBs, have a structure that would seem to fluoresce well, but the chlorine substitution on the rings causes what is referred to as the heavy-atom effect, resulting in non-radiative relaxation from the excited state and a dramatic reduction in fluorescence. In fact the reduction is so significant that PCBs are essentially non-fluorescent molecules.

The environment in which the PAH exists also has a substantial influence on the decay rate. Quenching, which refers to any process that causes a decrease in the decay time (as well as the

intensity) of the fluorescence, is dependent on conditions like oxygen levels, solvent availability, solvent viscosity, and a myriad of other matrix dependent conditions. An example of this can be found with the fluorescence of PAHs in fuels (gasoline, diesel, or kerosene) vs. coal tar oil. The coal tar oil can often contain more PAHs than the fuels, but the fluorescence lifetime is much shorter and the total fluorescence of fuels is often 2 to 3 orders of magnitude more intense. If one were to dissolve coal tar in a solvent such as hexane, its fluorescence intensity would rival that of fuels because the solvent matrix is simply more suited to allow fluorescence to occur.

Figure 3 illustrates the differing decay times one might observe for 4 different PAHs, along with the time profile of the laser pulse that excited them. Now remember, these are large populations of PAHs being excited and while some begin emitting immediately, other individual PAH molecules "wait" many nanoseconds before emitting a photon. What is plotted here is a picture of the distribution of times that the PAHs are remaining in the excited state before emitting photons. Now in our case (sediments) we have many different PAHs of differing ring number and substitution levels. The bold curve in Figure 3 illustrates the fluorescence decay profile that would result if we observed the fluorescence of all four PAHs simultaneously. This is the fluorescence waveform that would result if all 4 different PAHs fluoresced with equal intensity (normalized to keep it on scale). This same concept is happening in the sediments. We are observing the sum of all the decay profiles for all the different PAHs that are absorbing and emitting photons with each pulse of the excitation laser. It should be noted that there is no predictable trend between decay rate and structure like the trend that exists between spectrum and structure as described below.

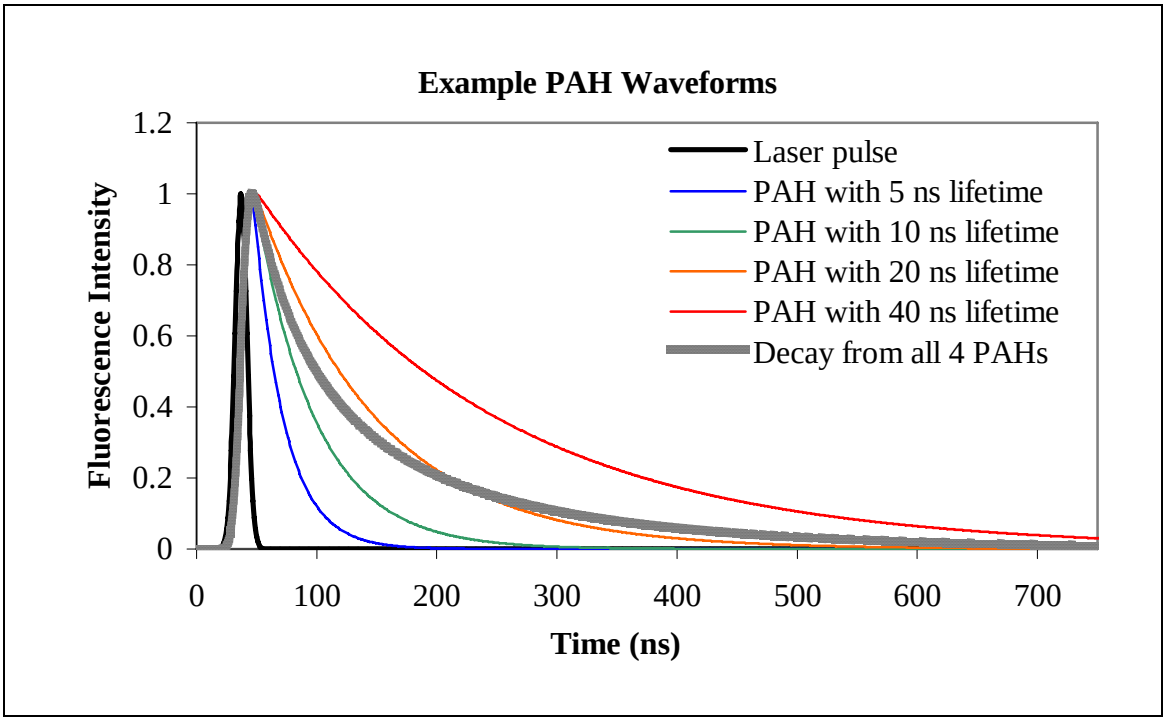

Figure 3. Temporal fluorescence examples

Of course the fluorescence decay profile observed in sediments is not made up of equal amounts of fluorescence from the various PAHs found in them. The wavelengths of light being emitted

by (spectra) and the relative fluorescence yields of the different PAHs are all quite different, but the concept is still valid. The decay profile of the PAHs observed in the sediment results from the decay profiles of a mixture of different PAHs, along with fluorescence from other materials in the matrix.

PAH spectra

Let's take a look at the other property of the fluorescence emission of the same 4 example PAHs we showed at in Figure 3. This time we'll examine not the time over which they fluoresce, but instead the distribution of energies found in the photons they emit. Remember that the fluorescence emission spectrum of a pure PAH is simply a graphical representation of the energy distribution of photons that are emitted from a large population of the PAHs as they release energy that was absorbed from the excitation beam of light (in our case, a laser). Spectra of pure PAHs are typically acquired by dissolving a sample of the pure PAH in a pure solvent that does not fluoresce.

Figure 4 depicts the fluorescence emission spectra of the same 4 PAHs used in the temporal example in Figure 3. The laser wavelength is also shown in Figure 4, demonstrating the principle that fluorescence occurs at longer wavelength (lower energy) than the excitation wavelength (also known as Stokes' shift). The basic trend is toward longer wavelength emission as more rings are added or substitution increases. Naphthalene emits at around 340 nm and the spectra "red-shift" as the number of rings increase. Another general property of fluorescence is that for a pure PAH the emission spectrum remains the same irrespective of what wavelength of light is used to excite them (Kasha's rule). This is not true for mixtures however, because changing the excitation wavelength might well change which PAH are being excited and to what degree. The bold spectrum in Figure 4 is the combined spectra of all 4 PAHs. This is a simplified illustration of what generally happens if we observe the total fluorescence of a mixture of different PAHs. Any change in the relative amounts of the differing PAHs or changes in the matrix in which they exist will cause a change in the spectrum of light actually emitted.

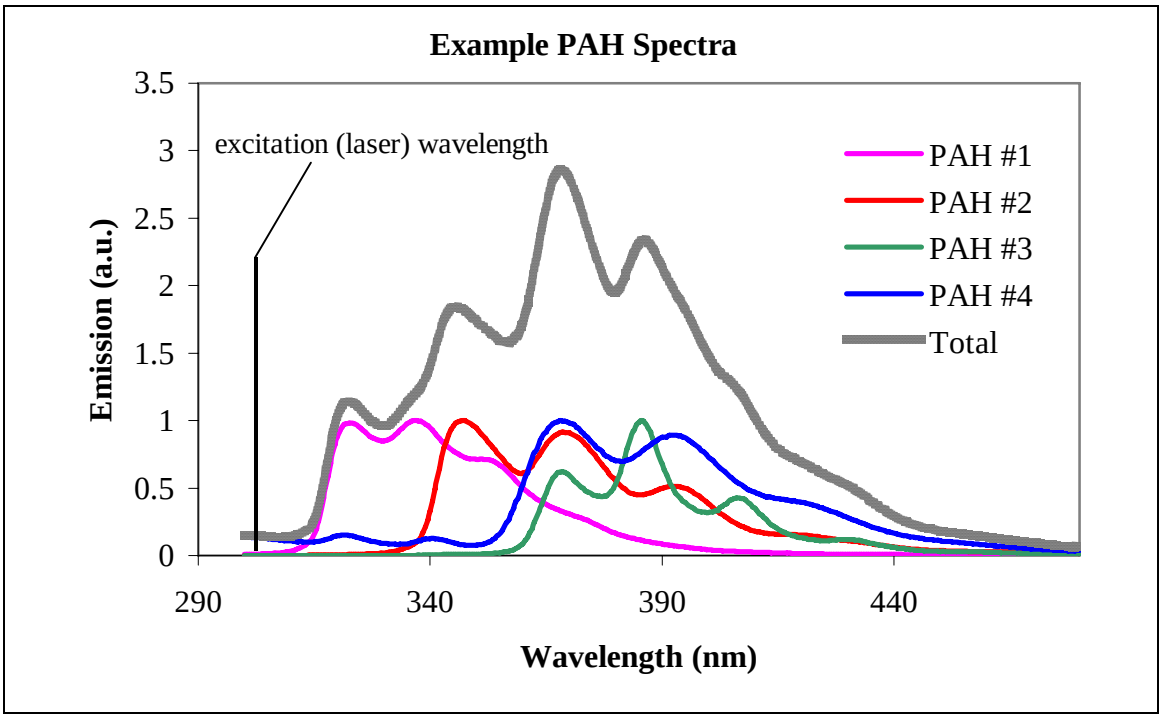

Figure 4. Spectral fluorescence examples

The fairly well defined structure (multiple peaks, valleys, and their various positions) of the spectra in Figure 4 suggests that perhaps one could use algorithms to extract information about the relative concentrations of the individual PAHs. While this is possible for very simple mixtures (2 to 3 PAHs) under controlled conditions, the algorithms quickly fail when many PAHs are present and interference fluorescence from humics, fulvics, and minerals is introduced. At best, one is able to use the overall shape of the total fluorescence spectrum to predict the *type* of mixture (diesel, coal tar, crude oil, etc.) and, in fact, this is routinely accomplished in environmental fluorescence forensics.

PAH multi-wavelength waveform (MWW)

The fluorescence of PAHs has both a spectral and temporal component. Real-world environmental samples typically contain at least several (if not dozens) of different PAHs along with other fluorophores, and the PAH fluorescence spectra overlap to form broad and fairly featureless spectral and temporal emission (compared to pure PAH spectra). If we were to record the temporal decay waveforms across the entire spectrum we would record what is called a wavelength-time matrix (WTM) that would describe the fluorescence emission completely. To create this we scan the emission selection monochromator from wavelength to wavelength, monitoring the pulsed emission vs. time at each wavelength with an oscilloscope.

Figure 5 contains the WTMs of diesel, jet, creosote, and gasoline on sand at several thousand ppm. The difference between the contaminants is clear and identification is straightforward. Dakota once employed these matrix style data sets to completely analyze the fluorescence of petroleum, oil, and lubricant (POL) contaminated soils. WTMs were (and still are) excellent for identifying/classifying the PAH fluorescence of environmental samples because of the unique information that both dimensions of PAH fluorescence exhibit when acquired in unison. While

WTMs make different contaminants readily discernable from one another, they are 3-dimensional and large. Also, the screening tool must be held still while the measurement is being made. All of these qualities make WTMs unwieldy for environmental screening tools that are designed to continuously log (typically 1 Hz) the presence of PAHs vs. time or depth.

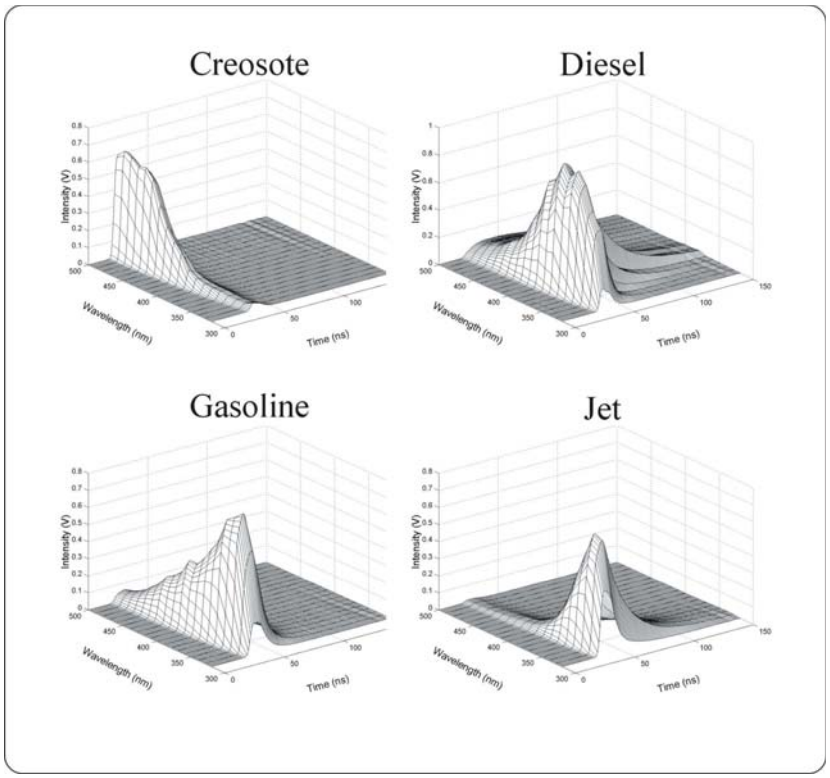

Figure 5. Example WTMs of common contaminants on sand

Because WTMs are so difficult to implement in screening mode, Dakota developed (and patented) a multiple-wavelength waveform (MWW) technique that allows multi-dimensional PAH fluorescence measurements to be acquired "on the fly". Figure 6 illustrates the concept. Select regions of the spectrum are monitored for their temporal response. The responses are optically delayed and recombined, and the resulting responses converge to form one two-dimensional waveform. There is sometimes overlap between the "channels" with long decay times, and the spectral regions being monitored are fewer and farther between than WTMs, but the resulting waveform still retains a unique combination of spectral and temporal fluorescence information that makes speciation and identification of PAH mixtures possible. Figure 7 illustrates the unique waveform produced by a variety of common PAH-containing environmental contaminants.

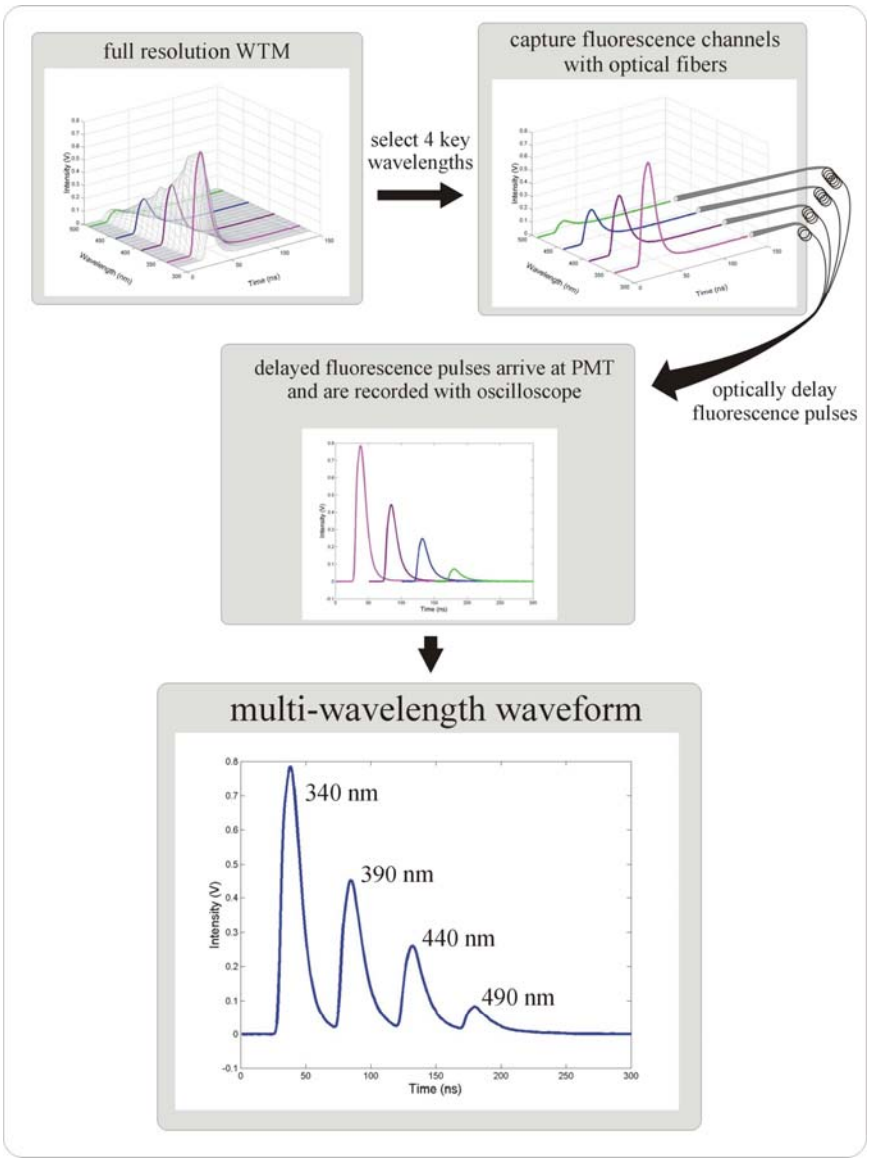

Figure 6. Multi-wavelength waveform concept

The UVOST system acquires waveforms at ~1 Hz and logs them to the hard drive continuously. As described below (see Calibration and normalization) the waveforms are integrated to achieve a quantitative result that is plotted vs. depth. The shape of the waveform yields information on the nature of the fluorescing material. With experience the analyst learns to look for changes or similarities in the waveform and is able to assess changes in the analyte concentration or the matrix. For instance, are the decay times for the various channels changing due to changes in the PAHs or perhaps changes in oxygen levels that affect quenching? Is the emission shifting to shorter or longer wavelengths due to changes in the amount of degradation via biological activity, weathering, or volatilization? Is the first channel (closest to the laser) getting more or less contribution from laser scatter due to improper mirror alignment? These and a myriad of other questions and answers can be gleaned from the shape of this simple, yet informative, data format.

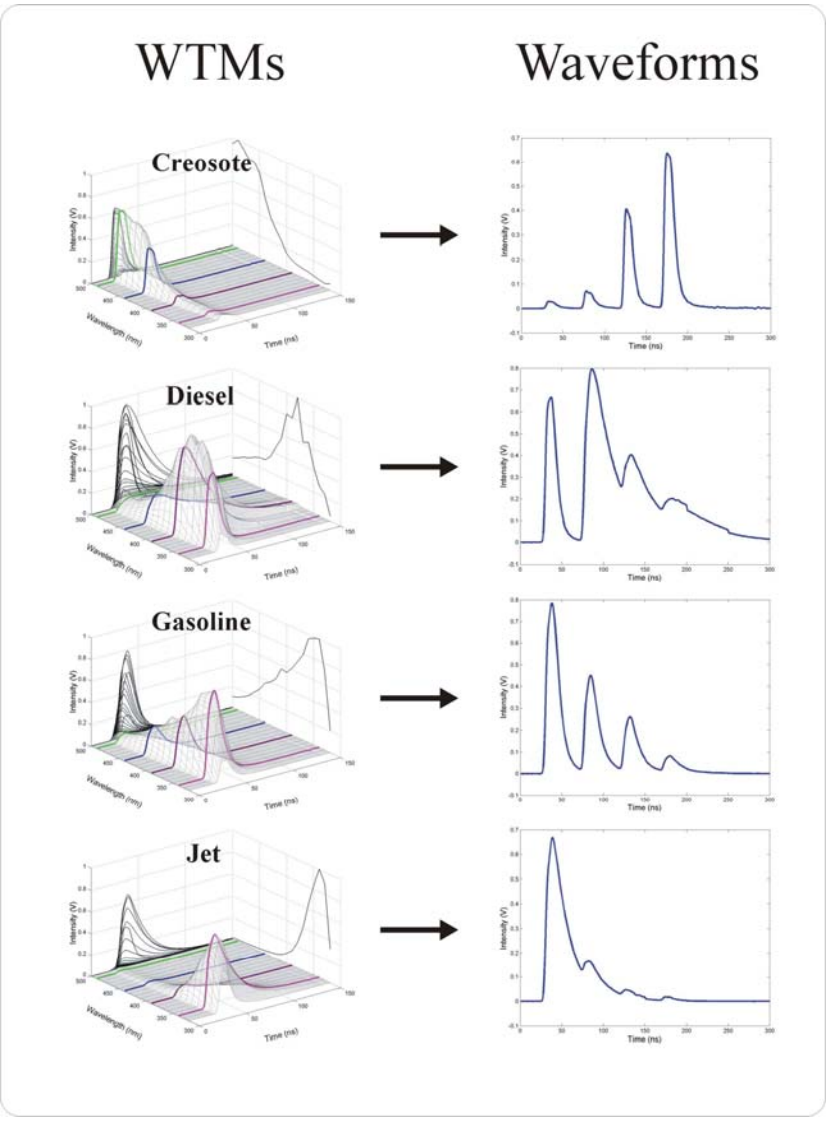

Figure 7. Waveforms of common contaminants

FVD colorization

The waveforms that are continuously logged vs. depth with UVOST contain a wealth of information, but to make this information easily interpretable in fluorescence vs. depth (FVD) log format, we need to further reduce the data to a one-dimensional data set that we can plot vs. depth. As discussed, the quantitative information is contained within the area under the waveform (total fluorescence) but how do we convert a waveform's shape into a singular entity? To accomplish this, Dakota has developed and implemented a novel technique that effectively converts the shape of the waveforms into colors. These colors are then used to fill in the area under the FVD that represents the total fluorescence measured at each point in the FVD. Figure 8, derived from data from a coal tar delineation project, illustrates the technique of colorizing the FVD according to the shape of the waveforms.

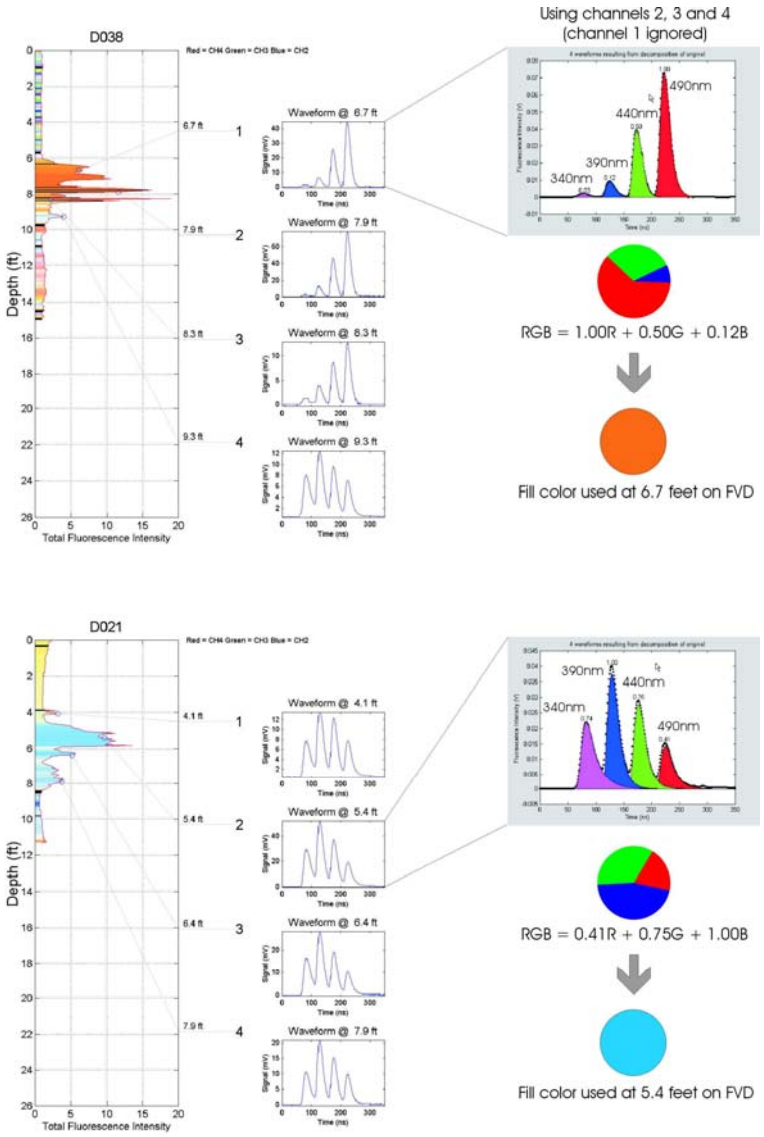

Figure 8. How color-coding is calculated

The result is a data presentation technique that allows the user to assess similarities or changes in the waveform shapes vs. depth by simply observing the colors that represent the shape of each and every waveform in the data set. This technique was used on the sediment measurements made in this project, both in the lab and in the field. It should be noted that the color black indicates that the algorithm that calculates the color failed to deconvolve the waveform successfully.

The colorization technique is limited to using three of the channels as a result of the red, green, and blue (RGB) color definition which computer colorization systems typically implement. A cyan, yellow, magenta, and black colorization system (CYMK) might allow the use of all four channels and is currently being considered as a replacement for RGB. The first three channels (340, 390, and 440 nm) were used to colorize the data in this study. The 490 nm channel was

used in a quantitative sense, but was ignored for the colorization. It should be noted that a strictly temporal change (where only the decay times change, not the spectrum) would not necessarily result in a color change, since the ratios of the 3 channels used might remain constant even though the area under the waveform itself will increase or decrease.

An added benefit of this technique is that it provides insight in situations where non-linear response behavior is encountered. Many contaminants such as coal tars, heavy crudes, and creosotes do not fluoresce with concentration in a linear fashion. For instance, a 10 fold increase in PAH concentration might produce very little or no increase in total fluorescence intensity. However, a spectral or temporal shift often does continue to occur with changes in concentration due to energy transfer, photon cycling, and other phenomenon. The color of the FVD fill continues to darken or shift in color, acting as an indicator of a change in the fluorescence of the sample, alerting the analyst to a possible increase in concentration. While this technique is less than analytical it does provide the analyst with additional insight into the distribution of PAHs in the soil vs. depth.

Calibration and normalization

The UVOST system response depends on a host of factors. These include laser energy, fiber termination quality, neutral density filter selection, parabolic mirror efficiency, and fiber length, just to name a few. To account for changes in these over time and location, a single point calibration and system check is performed. A reference emitter (coined M1) is placed on the sapphire window and the response is measured. The M1 solution is permanently stored in a quartz cuvette for convenience and the measurement takes place through the wall of the cuvette. This proprietary mix of hydrocarbons fluoresces efficiently across the entire system and serves as both an indicator of system function and as a data normalization benchmark.

The total fluorescence intensity (area under the waveform) of M1 serves to normalize the data from the push that immediately follows the reference emitter measurement. All the FVD logs are presented as a percentage of the signal achieved with M1. The area under every waveform in the data set is integrated, resulting in a pico-Volt-seconds unit (picoseconds * V or pVs). These values are divided by the pVs measured for M1, and the result is multiplied by 100. The result is a log with x-axis units of percent of M1. This creates a normalized data set that takes into account the entire system performance, from end to end (laser to oscilloscope). The shape of the M1 waveform acts to guide the operator in assessing proper alignment of the detection system. The relative contribution for each channel and the shape of M1 waveform is monitored for consistency to insure that the waveforms remain consistent from day to day.

APPENDIX H

SOIL AND GROUNDWATER DATA
(INCLUDED ON CD)

APPENDIX H1

GROUNDWATER SAMPLING RESULTS COMPARED TO RESIDENTAL SCREENING LEVELS (INCLUDED ON CD)

APPENDIX H2

SOIL SAMPLING RESULTS COMPARED TO RESIDENTAL SCREENING LEVELS (INCLUDED ON CD)

APPENDIX H3

SOIL SAMPLING RESULTS COMPARED TO INDUSTRIAL SCREENING LEVELS (INCLUDED ON CD)

APPENDIX I

CITY OF CHICAGO MUNICIPAL CODE CHAPTER 11-8
WATER SUPPLY AND DISTRIBUTION SYSTEMS

CHICAGO GROUNDWATER ORDINANCE

In May 1997, the Chicago City Council passed a groundwater ordinance, set forth below, prohibiting the installation of new potable water supply wells. The purpose is to limit the potential for persons to be exposed to contaminants by ingesting groundwater. Since new potable wells are prohibited, groundwater contamination is not a potential source of exposure for the vast majority of sites in the city. Limiting the potential exposure pathways to those posed by ingesting or inhaling soil makes cleanups more practical and cost effective. Site owners enrolled in the Illinois Site Remediation Program still must test and report groundwater impacts from their site, however.

The City of Chicago and the Illinois Environmental Protection Agency have a memorandum of understanding which acknowledges the City's groundwater ordinance as an acceptable "institutional control" under the state's TACO guidelines.

* * * *

Municipal Code of Chicago, Illinois
Chapter 11-8 WATER SUPPLY AND DISTRIBUTION SYSTEMS*

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* **Editor's note:** Coun. J. 3-28-01, p. 55444, § 1, repealed Ch. 11-8, in its entirety, which pertained to water supply and distribution systems. Subsequently, Amend Coun. J. 11-28-01, p. 72895, § 1 added provisions designated as § 11-8-390. Former Ch. 11-8 (title) has been restored at the discretion of the editor to accommodate inclusion of provisions designated as 11-8-390. See the Code Comparative Table.

11-8-390 Potable water wells.
For purposes of this section, "potable water" is any water used for human consumption, including but not limited to water used for drinking, bathing, washing dishes, preparing foods and watering gardens in which produce intended for human consumption is grown. No groundwater well, cistern or other groundwater collection device installed after May 14, 1997, may be used to supply any potable water supply system, except at points of withdrawal by the City of Chicago or by a unit of local government pursuant to intergovernmental agreement with the City of Chicago.
(Added Coun. J. 11-28-01, p. 72895, § 1)

City of Chicago
Richard M. Daley, Mayor

Department of Environment

Henry L. Henderson
Commissioner

Twenty-fifth Floor
30 North LaSalle Street
Chicago, Illinois 60602-2575
(312) 744-7606 (Voice)
(312) 744-6451 (FAX)
(312) 744-3586 (TTY)
http://www.ci.chi.il.us

July 1, 1997

Mr. Gary P. King
Manager, Division of Remediation Management
Bureau of Land
Illinois Environmental Protection Agency
1001 N. Grand Avenue, East
Springfield, IL 62702

RECEIVED
JUL 0 3 1997
I.E.P.A. / B.O.L.

Re: Chicago Ordinance No. 097990

Dear Mr. King:

Pursuant to 35 Ill. Adm. Code 742.1015(l)(2), Section 11-8-385 and 11-8-390 of the Municipal Code of Chicago, as amended by Ordinance No. 097990, apply to all areas within the corporate limits of the City of Chicago.

Sincerely,

Henry L. Henderson
Commissioner

cc: Mort Ames
Asst. Corp. Counsel

Chicago Blue Recycling
Please Recycle!

EXHIBIT
B

Chicago Works

FORM C.C. 424 3M 4-85

Be It Ordained by the City Council of the City of Chicago:

SECTION 1. Chapter 11-8 of the Municipal Code of Chicago is hereby amended by adding a new Section 11-8-385 and by amending Section 11-8-390 by inserting the language in italics, as follows:

11-8-385 Potable Water Defined.

Potable water is any water used for human consumption, including, but not limited to water used for drinking, bathing, washing dishes, preparing foods and watering gardens in which produce intended for human consumption is grown.

11-8-390 Prohibited Use Of Secondary Water; *Prohibited Installation Of New Potable Water Supply Wells.*

No secondary water shall overflow into or be discharged into any surge tank, storage tank, or reservoir, or shall in any way be piped or conveyed into the water supply system of any building, structure, or premises to become a part of or be mixed with the fresh water supply from the mains of the Chicago Waterworks System either inside of the premises or in the water service pipe. Secondary water shall not be piped to or used in any plumbing fixture, or for cooling crushers, rollers, or mixers where foods, candies, liquids or materials are manufactured for human or animal consumption. No connection, tap, or opening shall be made in a water distribution system other than an approved water distribution system which will permit such water being used for drinking.

Wherever the fire-protective equipment in any building, structure or premises has service from the Chicago Waterworks System, no pipe or other conduit which conveys secondary water shall be cross-connected to the fire-protective equipment. All fire-protective equipment connected to the Chicago Waterworks System shall be constructed in such manner that

EXHIBIT

A

all tanks, pipes, pumps, surge tanks, and fire hydrants can be thoroughly drained, flushed and cleaned by the owners of such equipment and premises and there shall be no direct connections from the tanks, pipes and other equipment to any drainage pipes or sewers. *No groundwater well, cistern or other groundwater collection device installed after the effective date of this amendatory ordinance may be used to supply any potable water supply system, except at points of withdrawal by the City of Chicago or by units of local government pursuant to intergovernmental agreement with the City of Chicago.*

SECTION 2. Section 2-30-030 of the Municipal Code of Chicago is hereby amended by deleting the language in brackets and inserting the language in italics, as follows:

2-30-030 Commissioner -- Powers And Duties Designated.

The commissioner of the environment shall have the following powers and duties:

* * * * *

(21) To enter into grant agreements, cooperation agreements and other agreements or contracts with governmental entities, private business and civic and community groups necessary to implement the Green Streets Program and other urban forestry, beautification and environmental enhancement programs; *and agreements to implement the State of Illinois Site Remediation Program;*

SECTION 3. This ordinance shall be in full force and effect from and after its passage and approval.

STATE OF ILLINOIS,
County of Cook. ss.

I, JAMES J. LASKI, City Clerk of the City of Chicago in the County of Cook and State of Illinois, DO HEREBY CERTIFY that the annexed and foregoing is a true and correct copy of that certain ordinance now on file in my office an ordinance amending Title 11, Chapter 8 and Title 2, Chapter 30 of the Municipal Code of Chicago by establishment of definition of potable water, regulation of potable water supply system and empowerment of commissioner of environment for implementation of State of Illinois Site Remediation Program.

I DO FURTHER CERTIFY that the said ordinance was passed by the City Council of the said City of Chicago on the fourteenth (14th) day of May, A. D. 1997 and deposited in my office on the fourteenth (14th) day of May A. D. 1997.

I DO FURTHER CERTIFY that the vote on the question of the passage of the said ordinance by the said City Council was taken by yeas and nays and recorded in the Journal of the Proceedings of the said City Council, and that the result of said vote so taken was as follows, to wit:

Yeas 47, Nays None.

I DO FURTHER CERTIFY that the said ordinance was delivered to the Mayor of the said City of Chicago after the passage thereof by the said City Council, without delay, by the City Clerk of the said City of Chicago, and that the said Mayor failed to return the said ordinance to the said City Council with his written objections thereto at the next regular meeting of the said City Council occurring not less than five days after the passage of the said ordinance.

I DO FURTHER CERTIFY that the original, of which the foregoing is a true copy, is entrusted to my care for safe keeping, and that I am the lawful keeper of the same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the corporate seal of the City of Chicago aforesaid, at the said City, in the County and State aforesaid, this twenty-seventh (27th) day of June, A. D. 1997

[L. S.]

James J. Laski

JAMES J. LASKI, City Clerk.

SUBSTITUTE

ORDINANCE

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF CHICAGO:

SECTION 1. The Municipal Code of the City of Chicago is hereby amended by adding a new Section 11-8-390, as follows:

11-8-390 Potable water wells.

For purposes of this section, "potable water" is any water used for human consumption, including but not limited to water used for drinking, bathing, washing dishes, preparing foods and watering gardens in which produce intended for human consumption is grown. No groundwater well, cistern or other groundwater collection device installed after May 14, 1997, may be used to supply any potable water supply system, except at points of withdrawal by the City of Chicago or by a unit of local government pursuant to intergovernmental agreement with the City of Chicago.

SECTION 2. This ordinance shall be in full force and effect from and after its passage and approval.

MEMORANDUM OF UNDERSTANDING BETWEEN THE CITY OF CHICAGO, ILLINOIS AND THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY REGARDING (A) THE USE OF A LOCAL POTABLE WATER SUPPLY WELL ORDINANCE AS AN ENVIRONMENTAL INSTITUTIONAL CONTROL AND (B) THE PROVISION OF INFORMATION RELATING TO "NO FURTHER REMEDIATION" DETERMINATIONS BY THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY TO THE CITY OF CHICAGO

I. PURPOSE AND INTENT

A. This Memorandum of Understanding ("MOU") is entered into between the City of Chicago, Illinois ("the City") and the Illinois Environmental Protection Agency ("Illinois EPA") for the purpose of (a) satisfying the requirements of 35 Ill. Adm. Code 742.1015 for the use of potable water supply well ordinances as environmental institutional controls and (b) ensuring that the City will be provided with copies of all "No Further Remediation" letters or determinations issued by the Illinois EPA pursuant to specific programs for sites located within the boundaries of Chicago, Illinois, in order to enable the City to maintain a complete and up-to-date registry of sites as required by 35 Ill. Adm. Code 742.1015(i)(5). The Illinois EPA has reviewed Sections 11-8-385 and 11-8-390 of the Municipal Code of Chicago as amended by Ordinance Number 097990 ("Potable Water Supply Well Ordinance"), attached as Attachment A, and has determined that the Municipal Code of Chicago prohibits the installation and use of new potable water supply wells by private entities but will allow the installation of potable water supply wells by the City and other units of local government pursuant to intergovernmental agreements with the City. In such cases, 35 Ill. Adm. Code 742.1015(a) provides that the City may enter into an MOU with the Illinois EPA to allow the use of the ordinance as an institutional control.

B. The intent of this Memorandum of Understanding is to (a) specify the responsibilities that must be assumed by the City to satisfy the requirements for MOUs as set forth at 35 Ill. Adm. Code 742.1015(i), and (b) require the Illinois EPA to provide the City with copies of all "No Further Remediation" letters or determinations that the Illinois EPA issues for sites located within the City of Chicago to enable the City to maintain a registry of sites pursuant to 35 Ill. Adm. Code 742.1015(i)(5).

II. DECLARATIONS AND ASSUMPTION OF RESPONSIBILITY

A. In order to ensure the long-term integrity of the Potable Water Supply Well Ordinance as an environmental institutional control and that risk to human health and the environment from contamination left in place in reliance on the Potable Water Supply Well Ordinance is effectively managed, the City hereby assumes the following responsibilities pursuant to 35 Ill. Adm. Code 742.1015(i):

1. The City will notify the Illinois EPA Bureau of Land of any changes to or requests for variance from the Potable Water Supply Well Ordinance at least 30 days prior to the date the local government is scheduled to take action on the proposed change or request (35 Ill. Adm. Code 742.1015(i)(4));

2. The City will maintain a registry of all sites within its corporate limits that have received "No Further Remediation" determinations from the Illinois EPA pursuant to specific programs (35 Ill. Adm. Code 742.1015(i)(5));

3. If the City determines to install a new potable water supply well(s), the City will review the registry of sites established under paragraph II.A.2. prior to siting such potable water supply well(s) within the area covered by the Potable Water Supply Well Ordinance, pursuant to 35 Ill. Adm. Code 742.1015(i)(6)(A);

4. If the City determines to install a new potable water supply well(s), the City will determine whether the potential source of potable water has been or may be affected by contamination left in place at the sites tracked and reviewed under paragraphs II.A.2. and 3. (35 Ill. Adm. Code 742.1015(i)(6)(B)); and

5. If the City determines to install a new potable water supply well(s), the City will take action as necessary to ensure that the potential source of potable water is protected from contamination or treated before it is used as a potable water supply (35 Ill. Adm. Code 742.1015(i)(6)(C));

6. If the City enters into intergovernmental agreements under Section 11-8-390 of the Municipal Code of Chicago to allow other units of local government to install new potable water supply well(s) within the corporate limits of the City, the City will require compliance with the procedures set forth in paragraphs II.A.3., 4., and 5. as a part of such agreements.

7. Notification under paragraph II.A.1. above, or other communications concerning this MOU directed to the Illinois EPA, shall be addressed to:

Manager, Division of Remediation Management
Bureau of Land
Illinois Environmental Protection Agency
P.O. Box 19276
Springfield, IL 62794-9276

B. In order to ensure the long-term integrity of the Potable Water Supply Well Ordinance as an environmental institutional control and that risk to human health and the environment from contamination left in place in reliance on the Potable Water Supply Well Ordinance or other specific programs can be effectively managed, the Illinois EPA hereby assumes

the following responsibilities:

1. The Illinois EPA will provide the City with copies of all "No Further Remediation" letters or determinations that it issues pursuant to 35 Ill. Adm. Code 742, and other specific programs, for sites located within the boundaries of the City at the time said letters or determinations are provided to remediation applicants.

2. Copies of "No Further Remediation" letters or determinations provided to the City pursuant to paragraph II.B.1. above, or other communications concerning this MOU directed to the City, shall be addressed to:

Commissioner
Chicago Department of Environment
25th Floor
30 North LaSalle Street
Chicago, IL 60602-2575

III. SUPPORTING DOCUMENTATION

The following documentation is required by 35 Ill. Adm. Code 742.1015(i) and is attached to this MOU:

A. Attachment A: A copy of the Potable Water Supply Well Ordinance certified by the city clerk or other official as the current, controlling law (35 Ill. Adm. Code 742.1015(i)(3)) and a statement of the authority of the City to enter into the MOU (35 Ill. Adm. Code 742.1015(i)(1)).;

B. Attachment B: Identification of the legal boundaries within which the Potable Water Supply Well Ordinance is applicable (35 Ill. Adm. Code 742.1015(i)(2)); and

IN WITNESS WHEREOF, the lawful representatives of the parties have caused this MOU to be signed as follows:

FOR: The City of Chicago, Illinois

BY: Joy L. Henderson DATE: July 1, 1997
Commissioner
Department of Environment
City of Chicago

FOR: Illinois Environmental Protection Agency

BY: Gary P. King DATE: July 3, 1997
(Name and title of signatory)
Division of Remediation Management
Bureau of Land

Version 6/27/97

STATE OF ILLINOIS,-
County of Cook. ss.

I, JAMES J. LASKI, City Clerk of the City of Chicago in the County of Cook and State of Illinois, DO HEREBY CERTIFY that the annexed and foregoing is a true and correct copy of that certain ordinance now on file in my office for an amendment of Title 11, Chapter 8 of Municipal Code of Chicago by addition of new Section 390 defining potable water and prohibiting use of certain groundwater collection device to supply any potable water supply system.

I DO FURTHER CERTIFY that the said ordinance was adopted by the City Council of the said City of Chicago on the twenty-eighth (28th) day of November, A.D. 2001 and deposited in my office on the twenty-eighth (28th) day of November, A.D. 2001.

I DO FURTHER CERTIFY that the vote on the question of the adoption of the said ordinance by the said City Council was taken by yeas and nays and recorded in the Journal of the Proceedings of the said City Council, and that the result of said vote so taken was as follows, to wit:

Yeas 47, Nays 0.

I DO FURTHER CERTIFY that the said ordinance was delivered to the Mayor of the said City of Chicago after the adoption thereof by the said City Council, without delay, by the City Clerk of the said City of Chicago, and that the said Mayor failed to return the said ordinance to the said City Council with his written objections thereto at the next regular meeting of the said City Council occurring not less than five (5) days after the adoption of the said ordinance.

I DO FURTHER CERTIFY that the original, of which the foregoing is a true copy, is entrusted to my care for safe keeping, and that I am the lawful keeper of the same.

[L.S.]

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the corporate seal of the City of Chicago aforesaid, at the said City, in the County and State aforesaid, this sixth (6th) day of December, A.D. 2001.

JAMES J. LASKI, City Clerk.

APPENDIX J

GUIDANCE FOR DESCRIBING TAR

STANDARD DESCRIPTORS – VISUAL OBSERVATIONS OF NAPL

Descriptive Term	Definition
No Visible Evidence	No visible evidence of oil on soil or sediment sample
Sheen	Any visible sheen in the water on soil or sediment particles or the core
Staining	Visible brown or black staining in soil or sediment; can be visible as mottling or in bands; typically associated with fine-grained soil or sediment
Coating	Visible brown or black oil coating soil or sediment particles; typically associated with coarse-grained soil or sediment such as coarse sand, gravels, and cobbles.
Oil Wetted	Visible brown or black oil wetting the soil or sediment sample; oil appears as a liquid and is not held by soil or sediment grains

APPENDIX K

OLD TOWN VILLIAGE WEST – SUPPLEMENTAL SITE INFORMATION
(INCLUDED ON CD)

ATTACHMENT K-1

APPROXIMATE LOCATION OF FORMER BUILDING CONTAINING TAR VAT

APPROXIMATE OLD TOWN VILLAGE WEST PARCEL BOUNDARY

West Elm Street

West Hobbie Street

North Crosby Avenue

(VACATED) N. HOWE STREET

NEW PRIVATE ALLEY

NEW PRIVATE ALLEY

REMEDIATION SITE #5

REMEDIATION SITE #4

REMEDIATION SITE #2

Police Station Parking Area

RELEASABLE

MAY 9 1 2005

REVIEWED MD

Figure 2
Remediation Site #5
Old Town Village West
SW Corner of W. Division & N. Howe Streets
Chicago, IL

PIONEER

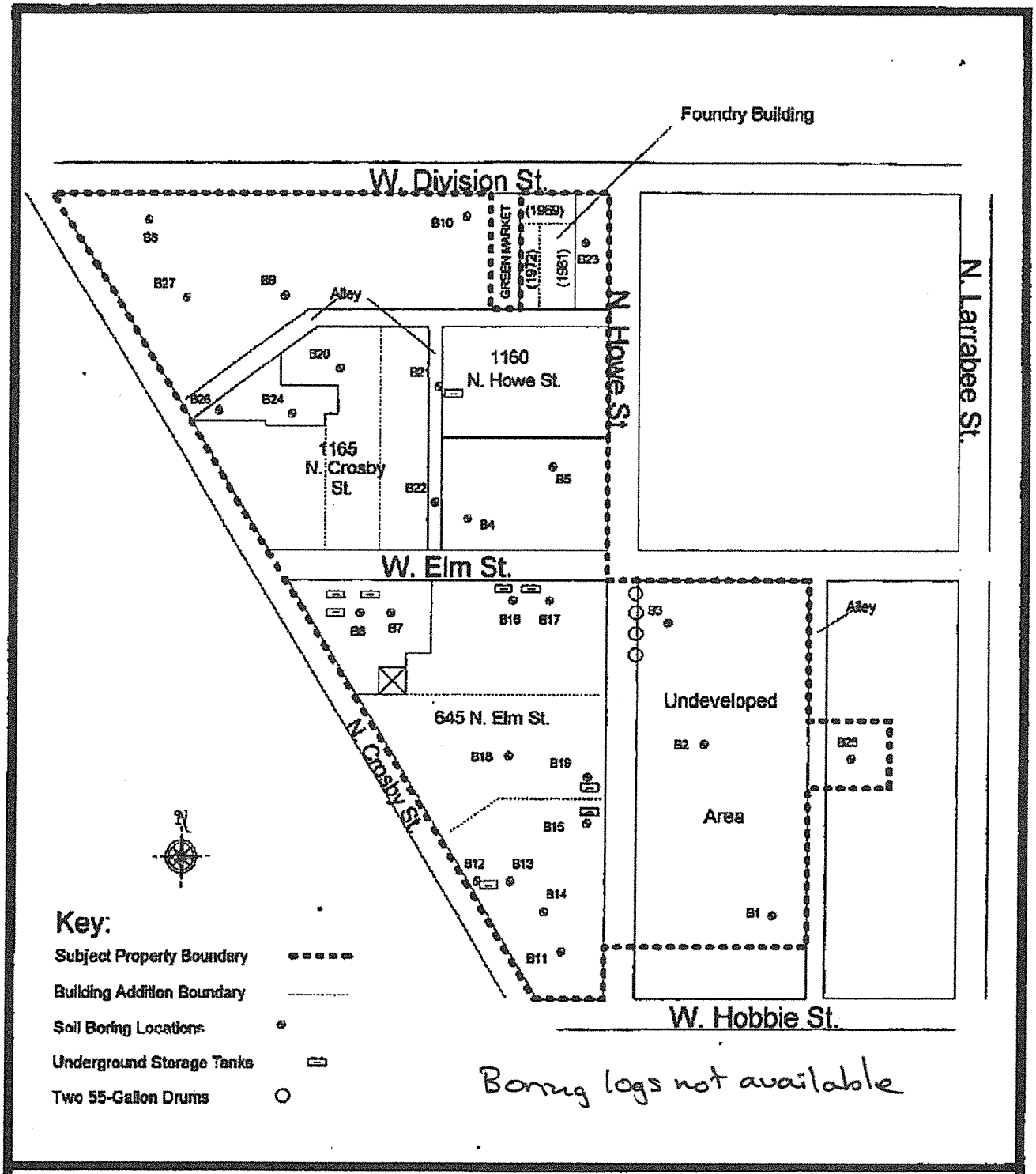
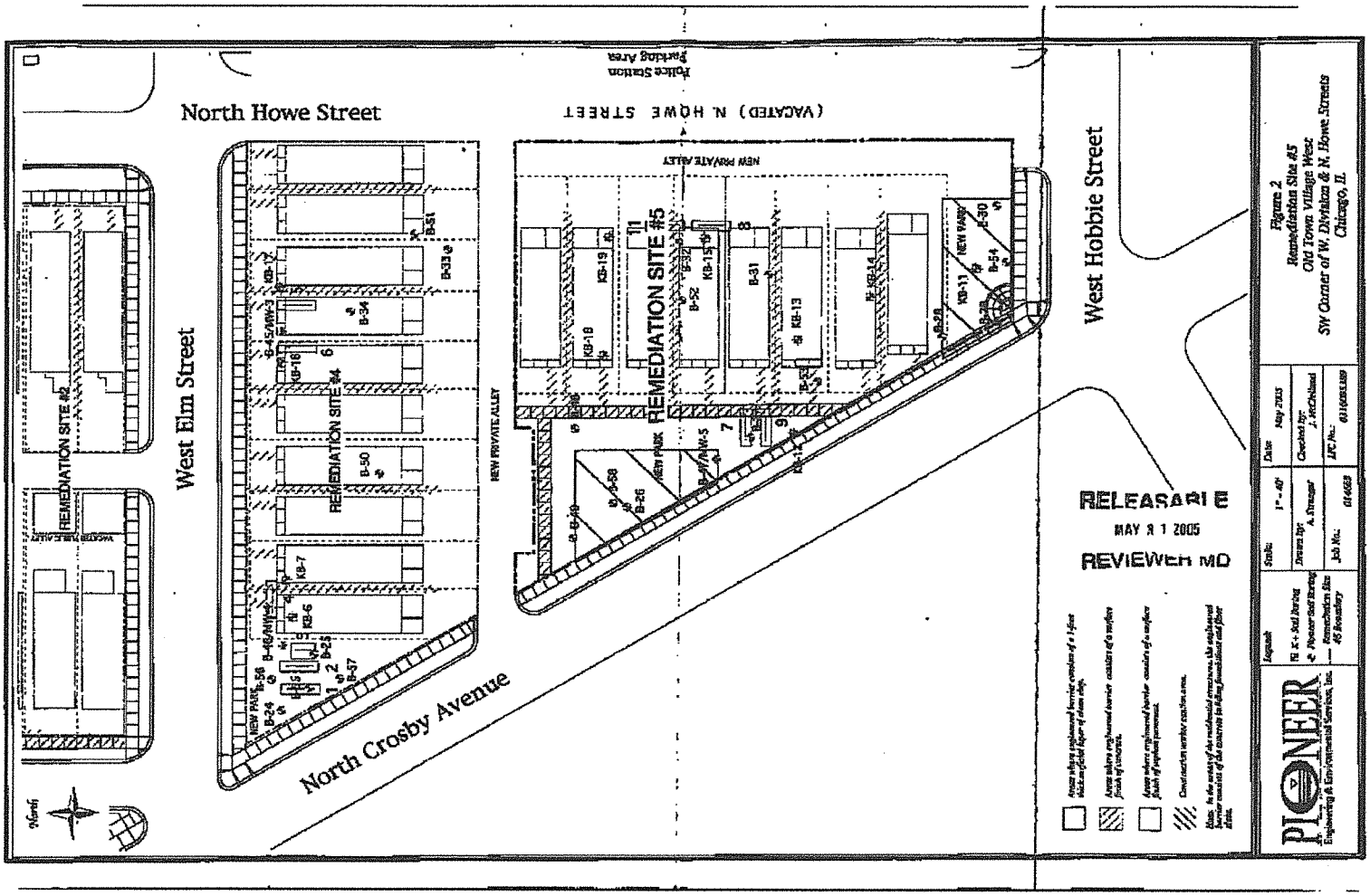


FIGURE 5 - BORING LOCATIONS

K-PLUS ENVIRONMENTAL	SPANJER BROTHERS, INC. CHICAGO, ILLINOIS	Date: June 9, 1995 - updated August 22, 2001 Scale: To Scale Project No. 5022


North Howe Street
West Elm Street
North Crosby Avenue
West Hobbie Street
(VACATED) N. HOWE STREET
Police Station Parking Area
NEW PRIVATE ALLEY
REMEDIATION SITE #2
REMEDIATION SITE #4
REMEDIATION SITE #5
RELEASABLE
MAY 31 2005
REVIEWER MD
PIONEER
Engineering & Environmental Services, Inc.
Figure 2
Remediation Site #5
Old Town Village West
SW Corner of W. Division & N. Howe Streets
Chicago, IL

rinted 08/04/2011 9:55AM by Richard.Jordan p. 67/168

TABLE NO. 6
Groundwater Sample Analytical Results: VOCs
Old Town Village West / Chicago, Illinois

B-45 B-46 B-47

ANALYTE	MW-1	MW-2	MW-3	MW-4	MW-5	Tier 1 Groundwater Remediation Objectives (Tier 1 GROs) (1) Class I	Class II
2-Butanone (MEK)	< 10	< 10	< 10	< 10	< 10	--	--
2-Hexanone	< 10	< 10	< 10	< 10	< 10	--	--
4-Methyl-2-pentanone (MIBK)	< 10	< 10	< 10	< 10	< 10	--	--
1,1-Dichloroethane	5.4	<5	<5	<5	<5	700	3,500
1,1-Dichloroethene	<5	<5	<5	<5	<5	7	35
1,2-Dibromo-3-Chloropropane	< 1	< 1	< 1	< 1	< 1	0.2	0.2
1,2-Dibromoethane	< 1	< 1	< 1	< 1	< 1	0.05	0.5
1,2-Dichloroethane	<5	<5	<5	<5	<5	5	25
1,2-Dichloropropane	<5	<5	<5	<5	<5	5	25
1,3-Dichloropropene (total)	<2	<2	<2	<2	<2	1	5
1,1,1-Trichloroethane	<10	<10	<10	<10	<10	200	1,000
1,1,2-Trichloroethane	<5	<5	<5	<5	<5	5	50
1,1,2,2-Tetrachloroethane	<5	<5	<5	<5	<5	--	--
Acetone	<50	<50	<50	<50	<50	700	700
Benzene	<2	<2	<2	<2	<2	5	25
Bromodichloromethane	<1	<1	<1	<1	<1	0.2	0.2
Bromoform	< 1	< 1	< 1	< 1	< 1	1	1
Bromomethane	<5	<5	<5	<5	<5	9.8	49
n-Butanol	<1000	<1000	<1000	<1000	<1000	700	700
Carbon Disulfide	< 10	< 10	< 10	< 10	< 10	700	3,500
Carbon Tetrachloride	<5	<5	<5	<5	<5	5	25
Chlorobenzene	<5	<5	<5	<5	<5	100	500
Chlorodibromomethane	<5	<5	<5	<5	<5	140	140
Chloroethane	<5	<5	<5	<5	<5	--	--
Chloroform	< 1	< 1	< 1	< 1	< 1	0.2	1
Chloromethane	<5	<5	<5	<5	<5	--	--
cis-1,2-Dichloroethene	14	<5	<5	<5	<5	70	200
Ethylbenzene	<2	<2	<2	<2	<2	700	1,000
Methylene Chloride	< 5	< 5	< 5	< 5	< 5	5	50
Styrene	<50	<50	<50	<50	<50	100	500
Tetrachloroethene	<5	<5	<5	<5	<5	5	25
Toluene	<2	<2	<2	<2	<2	1,000	2,500
trans-1,2-Dichloroethene	<5	<5	<5	<5	<5	100	500
Trichloroethene	11	<5	<5	<5	<5	5	25
Vinyl Acetate	< 10	< 10	< 10	< 10	< 10	7,000	7,000
Vinyl Chloride	<2	<2	<2	<2	<2	2	10
Total Xylenes	<10	<10	<10	<10	<10	10,000	10,000

Notes:

Results in ug/L (parts per billion)

"<" indicates not detected at stated dection limits

"--" indicates value not available

Shaded/Bolded cell indicates concentration detected above Tier 1 GRO for Class II Groundwater

(1) Pursuant to 35 IAC 742-Tiered Approach to Corrective Action Objectives

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TABLE NO. 7
Groundwater Sample Analytical Results: PNAs
Old Town Village West/ Chicago, Illinois

						Tier 1 Groundwater Remediation Objectives (Tier 1 GROs) [1]	
ANALYTE	MW-1	MW-2	MW-3	MW-4	MW-5	Class I	Class II
Naphthalene	<10	<10	<10	<10	<10	140	220
Acenaphthene	<18	<18	<18	<18	<18	420	2,100
Anthracene	<6.6	<6.6	<6.6	<6.6	<6.6	2,100	10,500
Fluoranthene	2.3	2.3	<2.1	<2.1	<2.1	280	1,400
Fluorene	<2.1	<2.1	<2.1	<2.1	<2.1	280	1,400
Pyrene	<2.7	<2.7	<2.7	<2.7	<2.7	210	1,050
CARCINOGENIC PNAs							
Benzo(a)anthracene	0.55	0.43	0.44	0.19	<0.13	0.13	0.65
Benzo(a)pyrene	0.8	0.55	<0.23	0.25	<0.23	0.2	2.0
Benzo(b)fluoranthene	0.29	0.4	<0.18	0.22	<0.18	0.18	0.9
Benzo(k)fluoranthene	<0.17	0.3	<0.17	0.18	<0.17	0.17	0.85
Chrysene	<1.5	<1.5	<1.5	<1.5	<1.5	1.5	7.5
Dibenzo(a,h)anthracene	<0.3	<0.3	<0.3	<0.3	<0.3	0.3	1.5
Indeno(1,2,3-cd)pyrene	<0.43	<0.43	<0.43	<0.43	<0.43	0.43	2.15
NON-CARCINOGENIC PNAs							
Acenaphthylene	<10	<10	<10	<10	<10	–	–
Benzo(g,h,i)perylene	0.88	<0.76	<0.76	<0.76	<0.76	–	–
Phenanthrene	<6.4	<6.4	<6.4	<6.4	<6.4	–	–

Notes:

Results in ug/L (parts per billion)
"<" indicates not detected at stated dection limits
"–" indicates value not available
Shaded/Bolded cell indicates concentration detected above Tier 1 GRO for Class II Groundwater

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TABLE NO. 8
Groundwater Sample Analytical Results: Metals
Old Town Village West / Chicago, Illinois

						Tier 1 Groundwater Remediation Objectives (Tier 1 GROs) [1]	
ANALYTE	*MW-1*	*MW-2*	*MW-3*	*MW-4*	*MW-5*	*Class I*	*Class II*
Arsenic	<5	<5	<5	<5	<5	50	200
Barium	<200	<200	<200	<200	<200	2,000	2,000
Cadmium	<20	<20	<20	<20	<20	5	50
Chromium	<50	<50	<50	<50	<50	100	1,000
Lead	<10	<10	<10	<10	<10	7.5	100
Mercury	< 1	< 1	< 1	< 1	< 1	2	10
Selenium	<5	<5	<5	<5	<5	50	50
Silver	<10	<10	<10	<10	<10	50	–

Notes:

Results in ug/L (parts per billion)

"<" indicates not detected at stated dection limits

"–" indicates value not available

Shaded/Bolded cell indicates concentration detected above Tier 1 GRO for Class II Groundwater

(1) Pursuant to 35 IAC 742-Tiered Approach to Corrective Action Objectives

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-18

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/27/01

Date End: 11/2701

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
131	50%			Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, No visual
–	0		3			No Recovery	
27.6	75%		6	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	
20.4	100%		9	CL		Gray-Brown Mottled silty CLAY with trace of coarse gravel, Hard and Moist	
8.2	100%		12				
8.0	100%		15				No odor, No visual
						Boring terminated @ 15'	
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig:	IR-A300
Driller:	Sean Markham
Geologist:	Jeff Paddock
LUST Incident No:	NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

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PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-19

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/27/01

Date End: 11/27/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
1.5	50%		3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, No visual
15.3	100%		6	SM		Brown medium grained well sorted silty SAND, Wet and Loose	
156	100%		9			Coarse sand seam @ 7' to 7.5', Wet	
305	100%		12				
147	100%		15	CL		Gray silty CLAY, Soft and Moist	No odor, No visual
			18			Boring terminated @ 15'	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Geologist: Jeff Paddock

Ground elevation: Feet

LUST Incident No: NA

Water Depth While Drilling: 7' Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-24

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/27/01

Date End: 11/27/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
5.5	75%		3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, No visual
75.0	75%		6				
57.0	75%		9	SW		Gray medium SAND, Loose and Moist	
7.4	75%		12	CL		Gray-Brown silty CLAY with trace coarse gravel, Firm and Moist	
8.1	100%		15			Boring terminated @ 15'	No odor, No visual
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Driller: Sean Markham

Geologist: Jeff Paddock

LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-25

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/27/01

Date End: 11/27/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
1.6	75%		3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, No visual
–	0		6			No Recovery	
456.9	100%		9	ML		Gray medium sandy SILT, Loose and Wet Moist	Strong petroleum odor
–	0		12			No Recovery	
16.7	100%		15	CL		Gray-Brown silty CLAY with trace gravel, Hard and Moist	No odor, No visual
			18			Boring terminated @ 15'	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Geologist: Jeff Paddock

Ground elevation: Feet

LUST Incident No: NA

Water Depth While Drilling: 6' Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-26

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/28/01

Date End: 11/28/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
<1	75%			Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, No visual
			3	ML		Gray sandy SILT, Loose and Moist	
<1	100%					Black silty SAND, trace of fine to medium gravel, Wet and Moist	
			6				
4	100%						
			9	SM			
340	100%					Coarse gravel seam @ 10' to 10.5', Wet	Strong Petroleum odor
			12				
60	100%						No odor, No visual
			15			Boring terminated @ 15'	
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Geologist: Jim Mizwicki

Ground elevation: Feet

LUST Incident No: NA

Water Depth While Drilling: 5' Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-27

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/28/01

Date End: 11/28/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
–	0		3	Fill		Brick Rubble-Unable to Sample	No odor, no visual
–	0		6				
36	100%		9	ML		Black-brown clayey SILT, trace of sand, Soft and Wet	
<1	100%		12	CL		Brown-Gray silty CLAY, Hard and Moist	
<1	100%		15				No odor, no visual
			18			Boring terminated @ 15'.	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Geologist: Jim Mizwicki

Ground elevation: Feet

LUST Incident No: NA

Water Depth While Drilling: 6' Water Depth After Drilling:NA

Project Number: 01466B

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PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-28

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/28/01

Date End: 11/28/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
--	0		3	Fill		Brick Rubble-Unable to Sample	No odor, no visual
--	0		6				
8	100%		9	CL		Black-brown to gray silty CLAY with trace fine sand, Soft and Moist	
<1	100%		12			Grades to gray silty CLAY, Hard and Moist @ 9'	
<1	75%		15				No odor, no visual
			18			Boring terminated @ 15'	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig:	IR-A300
Driller:	Sean Markham
Geologist:	Jim Mizwicki
LUST Incident No:	NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-29

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/28/01

Date End: 11/28/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
<1	75%			Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, no visual
<1	75%		3				
<1	75%		6	ML		Gray clayey SILT, Firm and Moist	
<1	100%		9	CL		Gray silty CLAY, Hard and Moist	
<1	100%		12				No odor, no visual
			15			Boring terminated @ 15'	
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Geologist: Jim Mizwicki

Ground elevation: Feet

LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

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PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-30

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/28/01

Date End: 11/28/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
–	0		3	Fill		Brick Rubble-Unable to Sample	
–	0		6				
20	100%		9	ML		Gray clayey SILT, Firm and Moist	No odor, no visual
<1	100%		12	CL		Gray silty CLAY, Hard and Moist	
<1	50%		15				No odor, no visual
			18			Boring terminated @ 15'	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Geologist: Jim Mizwicki

Ground elevation: Feet

LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

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PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-31

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/28/01

Date End: 11/28/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
<1	75%		3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, No visual
3	75%		6				
<1	100%		9				
<1	100%		12	SC		Gray clayey SAND with trace fine-grained gravel, Firm and Moist	No odor, No visual
			15			Boring terminated @ 12'	
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Driller: Sean Markham

Geologist: Jim Mizwicki

LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

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PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-32

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/28/01

Date End: 11/28/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
<1	100%		3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, no visual
3	100%		6				
<1	100%		9	ML		Gray to brown clayey SILT, Soft and Moist	
<1	100%		12	CL		Brown to gray silty CLAY, Hard and Moist	
<1	100%		15				No odor, no visual
			18			Boring terminated @ 15'	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Geologist: Jim Mizwicki

Ground elevation: Feet

LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-33

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/28/01

Date End: 11/28/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
1			3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris; Loose and Moist	No odor, no visual
<1			6				
4			9	CL		Gray-Brown silty CLAY with trace gravel, Hard and Moist	
<1			12				
<1			15				No odor, no visual
			18			Boring terminated @ 15'	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Driller: Sean Markham

Geologist: Jim Mizwicki

LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

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PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-34

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 11/28/01

Date End: 11/28/01

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
2			3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, no visual
<1			6				
272			9				Black, strong petroleum odor
11			12	CL		Gray-Brown silty CLAY with trace gravel, Hard and Moist	
4			15			Boring terminated @ 15'	No odor, no visual
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Geologist: Jim Mizwicki

Ground elevation: Feet

LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-45/MW-3

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 1/8/02

Date End: 1/8/02

FID (ppm)	Sample Recovery	Sample	Depth	Soil Class	Lithology	Description	Notes
--	0			Fill		Brick rubble-unable to sample	No odor, No visual
			3				
7.5	75%			SC		Black Clayey SAND, Soft and moist	Slight oil odor
17.5	75%		6				
			9				
8.5	100%			CL		Gray silty CLAY, Soft and moist	
			12				
8.5	100%						No odor, No visual
			15			Boring terminated @ 15'	
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Geologist: Jeff Paddock

Ground elevation: 97.40'

LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

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PIONEER Engineering & Environmental Services, Inc.

Groundwater Monitoring Well Completion Report

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Groundwater Monitoring Well ID:

MW-3

B-45

Project Number:	01466B	Top of Inner Casing:	99.80'
Geologist:	Jeff Paddock	Ground elevation:	97.40'
Date Drilled:	1/8/02	Total Depth of Borehole:	15.45'
Borehole Diameter:	4"	Depth to Water:	8.61' from TOIC

Soil Description	Soil Class	Graphic Log	FID	Depth	Monitoring Well Completion	Annulus Material
Brick rubble-Unable to sample	Fill		<1			Medium-Bentonite Chips
Black clayey sand, Soft and Moist	ML		7.5	3		
			17.5	6		
Gray silty CLAY with trace fine gravel, Hard and Moist	CL		8.5	9		#7 Quartz Sand
			8.5	12		
Boring terminated @ approximately 15'				15		
				18		

Notes: Well constructed using 2" Schedule 40 PVC Riser and 2" 0.01" Slot Casing.

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PIONEER Engineering & Environmental Services, Inc.

Boring Log

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Boring No.: B-46/MW-4
Date Begin: 1/8/02
Date End: 1/8/02

FID (ppm)	Sample Recovery	Sample	Depth	Soil Class	Lithology	Description	Notes
1.5	75%		0	Fill		Brick rubble-unable to sample	No odor, No visual
1.0	100%		3	SC		Black Clayey SAND, soft and moist	
12.0	50%		6	CL		Gray silty CLAY, stiff and moist	Strong Gasoline Odor
2.0	75%		9				
2.0	100%		12				No odor, No visual
			15			Boring terminated @ 15'	
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300
Geologist: Jeff Paddock
Ground elevation: 97.46'
LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Groundwater Monitoring Well Completion Report

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Groundwater Monitoring Well ID:

MW-4

B-46

Project Number:	01466B	Top of Inner Casing:	99.88'
Geologist:	Jeff Paddock	Ground elevation:	97.46'
Date Drilled:	1/8/02	Total Depth of Borehole:	15.34'
Borehole Diameter:	4"	Depth to Water:	7.81' from TOIC

Soil Description	Soil Class	Graphic Log	FID	Depth	Monitoring Well Completion	Annulus Material
Brick rubble-Unable to sample	Fill		1.5			Medium-Bentonite Chips
Black clayey sand, Soft and Moist	SC		1.0	3		
Gray silty CLAY with trace fine gravel, Hard and Moist	CL		12.0	6		#7 Quartz Sand
			2.0	9		
			2.0	12		
Boring terminated @ 15'				15		
				18		

Notes: Well constructed using 2" Schedule 40 PVC Riser and 2" 0.01" Slot Casing.

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PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-47/MW-5

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL.

Date Begin: 1/8/02

Date End: 1/8/02

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
2.4	75%		3	Fill		Brick rubble-Unable to sample	No odor, No visual
--	0		6			No Recovery	
27.1	75%		9	CL		Gray to brown mottled silty CLAY, with trace of fine sand	
83.3	100%		12				
12.5	100%		15				No odor, No visual
			18			Boring terminated @ 15'	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig:	IR-A300
Driller:	Sean Markham
Geologist:	Jeff Paddock
LUST Incident No:	NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Groundwater Monitoring Well Completion Report

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Groundwater Monitoring Well ID:

MW-5

B-47

Project Number:	01466B	Top of Inner Casing:	99.93'
Geologist:	Jeff Paddock	Ground elevation:	97.33'
Date Drilled:	1/8/02	Total Depth of Borehole:	15.60'
Borehole Diameter:	4"	Depth to Water:	8.30' from TOIC

Soil Description	Soil Class	Graphic Log	FID	Depth	Monitoring Well Completion	Annulus Material
Brick rubble-Unable to sample	Fill		2.4			Medium-Bentonite Chips
No Recovery			–	3		
Gray to brown mottled silty CLAY with trace fine-grained sand, Hard and Moist	CL		27.1 83.3 12.5	6 9 12		#7 Quartz Sand
Boring terminated @ 15'				15 18		

Notes: Well constructed using 2" Schedule 40 PVC Riser and 2" 0.01" Slot Casing.

C:\Program Files\Well Logger 2.70\14558_Wells.wt2

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-50

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 1/8/02

Date End: 1/8/02

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
4.6			3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, No visual
2.5			6	SC		Medium clayey SAND, Soft and moist	Slight petroleum odor
5.7			9	CL		Gray-Brown Mottled silty CLAY with trace of sand and gravel Coarse gravel seam @ 9' to 9.5', Wet	
7.5			12				
5.7			15				No odor, No visual
			18			Boring terminated @ 15'	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Geologist: Jeff Paddock

Ground elevation: Feet

LUST Incident No: NA

Water Depth While Drilling: 9' Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-51

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 1/8/02

Date End:

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
2.5	100%		3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, No visual
4.5	75%		6				Slight petroleum odor
5.6	100%		9	CL		Gray to brown mottled silty CLAY, with trace of gravel, firm and moist	
--	0		12			No recovery	
4.7	75%		15	CL		Gray to brown mottled silty CLAY with trace of gravel, hard and moist	No odor, No visual
			18			Boring terminated @ 15'	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Driller: Dragan Zivojinovich

Geologist: Jeff Paddock

LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-S2

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 1/8/02

Date End:

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
						Brick Rubble-Unable to Sample	
–	0						No odor, No visual
			3	Fill			
–	0						Strong petroleum odor
			6			Gray mottled silty CLAY, with fine-coarse gravel	
89.9	75%						
			9			Coarse gravel seam @ 11' to 11.5', Wet	
61.0	75%			CL			
			12				
16.4	1005						No odor, No visual
			15			Boring terminated @ 15'	
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Geologist: Jeff Paddock

Ground elevation: Feet

LUST Incident No: NA

Water Depth While Drilling: 11' Water Depth After Drilling:NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-53

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 1/14/02

Date End: 1/14/02

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
2.0	75%		3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, No visual
8.0	100%		6				
14.2	75%		9	CL		Gray to brown mottled silty CLAY, with trace sand and gravel, firm and moist	
10.1	100%		12				
4.2	100%		15				No odor, No visual
			18			Boring terminated @ 15'	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Driller: Sean Markham

Geologist: Jeff Paddock

LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

Page 1

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-54

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 1/14/02

Date End: 1/14/02

FID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
3.5	75%		3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, no visual
3.8	75%		6				
8.3	75%		9	CL		Gray to brown mottled silty CLAY, with trace of gravel, firm and moist	
9.1	100%		12				
5.1	100%		15			Boring terminated @ 15'	No odor, no visual
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Driller: Sean Markham

Geologist: Jeff Paddock

LUST Incident No: NA

Water Depth While Drilling: NA Water Depth After Drilling:NA

Project Number: 01466B

Page 1

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-55

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 5/24/02

Date End: 5/24/02

PID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
--	25%		3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, no visual
--	10%		6				
--	75%		9				Slight Petroleum odor
--	100%		12	CL		Gray to brown mottled silty CLAY, with trace of gravel, firm and moist	No odor, no visual
			15			Boring terminated @ 12'	
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Driller: Dragan Zivojinovich

Geologist: Jeff Paddock

LUST Incident No: NA

Water Depth While Drilling:NA Water Depth After Drilling: NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-56

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 5/24/02

Date End: 5/24/02

PID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
--	75%		3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist, Wet @ 9'	No odor, no visual
--	100%		6				
--	75%		9				
--	100%		12	CL		Gray to brown mottled silty CLAY, with trace of gravel, firm and moist	Slight Petroleum odor
			15			Boring terminated @ 12'	
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Driller: Dragan Zivojinovich

Geologist: Jeff Paddock

LUST Incident No: NA

Water Depth While Drilling: 9' Water Depth After Drilling: NA

Project Number: 01466B

Page 1

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-57

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 5/24/02

Date End: 5/24/02

PID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
--	75%		3	Fill		Dark-Brown medium to coarse sandy clay (FILL) with wood, limestone, cinders, and brick debris, Loose and Moist	No odor, no visual
--	75%		6				
--	75%		9				
--	100%		12	CL		Gray to brown mottled silty CLAY, with trace of gravel, firm and moist	No odor, no visual
			15			Boring terminated @ 12'	
			18				

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Driller: Dragan Zivojinovich

Geologist: Jeff Paddock

LUST Incident No: NA

Water Depth While Drilling:NA Water Depth After Drilling: NA

Project Number: 01466B

PIONEER Engineering & Environmental Services, Inc.

Boring Log

Boring No.: B-58

Site: Old Town Village West
W. Division & N. Howe Streets
Chicago, IL

Date Begin: 5/24/02

Date End: 5/24/02

PID (ppm)	Sample Recovery	Sample	Depth Feet	Soil Class	Lithology	Description	Notes
--	0		3	Fill		No Recovery, Brick Rubble	
--	0		6				
--	0		9				
--	0		12				
--	75%		15	CL		Gray to brown mottled silty CLAY, with trace of gravel, firm and moist	No odor, No visual
--	75%		18				No odor, No visual
						Boring terminated @ 18'	

Completion Notes:
Hatch pattern denotes sample collected for chemical analysis.

Drill Rig: IR-A300

Driller: Dragan Zivojinovich

Geologist: Jeff Paddock

LUST Incident No: NA

Water Depth While Drilling:NA Water Depth After Drilling: NA

Project Number: 01466B

printed 08/04/2011 10:05AM by Richard.Jordan p. 1/78 07/06/2010 1:58PM L 170000504274 0316085389 OLD TOWN VILLAGE WEST 31A 12/17/2004 98,730 L008445 L16-00162 B:32722 F:50497
I:00000015 EPA4247 01/13/2005 EPA4561 07/06/2010

PIONEER Engineering & Environmental Services, Inc.

04-23079

700 North Sacramento Boulevard, Suite 101 • Chicago, Illinois 60612
312.587.1021 • Fax: 312.587.8210
www.pioneerenvironmental.com

0316085389
Old Town Village West
SR/Tech

December 17, 2004

Illinois Environmental Protection Agency
Bureau of Land #24
Remedial Project Management Section
Site Remediation Program
1021 North Grand Ave. East
P.O. Box 19276
Springfield, IL 62794-9276
Attn.: Mr. Todd Hall

RE: Remedial Action Completion Report
REMEDIATION SITE #4
0316085389 – Cook County
Chicago / Old Town Village West.

ORIGINAL

Dear Mr. Hall:

Pioneer Engineering & Environmental Services, Inc. (Pioneer) is submitting three copies of a *Remedial Action Completion Report*, dated December 10, 2004, and the associated DRM-2 form for the above referenced site. Please note that the Remediation Site described within this report was initially part of a larger parcel that was entered into the Illinois EPA's Site Remediation Program in May 2002. For redevelopment purposes, the Remediation Site has been separated from the larger parcel to obtain a distinct comprehensive NFR Letter and has been referred to as Remediation Site #4. Remediation Site #4 is comprised of approximately 0.681 acres located in the south-central portion of the larger 4.4-acre parcel.

Due to timing constraints associated with pending sales of the residential units at this redevelopment site, Pioneer and the Remediation Applicant would appreciate any efforts to expedite your review of this project. Pioneer appreciates your time with this matter and thanks you in advance for your review of this information. Please contact me with any questions or comments at (773) 722-9200.

Respectfully submitted,
PIONEER ENGINEERING & ENVIRONMENTAL SERVICES, INC.

Jeffrey McClelland, P.E.
Senior Project Manager

Encl.

cc: Rob Eshoo, MCL Companies (w/Encl.)

RELEASABLE
DEC 21 2004
REVIEWER MM

RECEIVED
DEC 21 2004
IEPA/BOL

Illinois Environmental Protection Agency
Bureau of Land
Remedial Project Management Section
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

FOR ILLINOIS EPA USE:
LOG NO. _____

Site Remediation Program Form (DRM-2)
(To Be Submitted with all Plans and Reports)

I. Site Identification:

Site Name: Old Town Village West - Remediation Site #4

Street Address : Southwest Corner of West Division & North Howe Streets

City: Chicago Illinois Inventory I. D. Number: 0316085389

IEMA Incident Number: NA

II. Remediation Applicant:

Applicant's Name: Rob Eshoo Company: Division & Crosby, LLC

Street Address: c/o MCL Companies, 455 E. Illinois Street, Suite 585

City: Chicago State: IL ZIP Code: 60611 Phone: 312.321.8900

I hereby request that the Illinois EPA review and evaluate the attached project documents in accordance with the terms and conditions of the Environmental Protection Act (415 ILCS 5), implementing regulations, and the review and evaluation services agreement.

Remediation Applicant's Signature: _____ Date: 12/10/04

III. Contact Person:

Contact's Name: Jeffrey McClelland Company: Pioneer Eng. & Envir. Services, Inc.

Street Address: 700 N. Sacramento Blvd., Suite 101

City: Chicago State: IL ZIP Code: 60612 Phone: 773.722.9200

IV. Review & Evaluation Licensed Professional Engineer or Geologist ("RELPEG"), if applicable:

RELPEG's Name: _____ Company: _____

Street Address: _____

City: _____ State: _____ ZIP Code: _____ Phone: _____

Registration Number: _____ License Expiration Date: _____

All information submitted is available to the public except when specifically designated by the Remediation Applicant to be treated confidentially as a trade secret or secret process in accordance with the Illinois Compiled Statutes, Section 7(a) of the Environmental Protection Act, applicable Rules and Regulations of the Illinois Pollution Control Board and applicable Illinois EPA rules and guidelines. The Illinois EPA is authorized to require this information under Sections 415 ILCS 5/58 - 58.12 of the Environmental Protection Act and regulations promulgated thereunder. Disclosure of this information is required as a condition of participation in the Site Remediation Program. Failure to do so may prevent this form from being processed and could result in your plan(s) or report(s) being rejected. This form has been approved by the Forms Management Center.

RECEIVED
DEC 2 1 2004
IEPA/BOL

V. Project Documents Being Submitted:

Document Title: Remedial Action Completion Report Date of Preparation of Plan or Report: 12/10/04

Prepared by: Pioneer Eng. & Envir. Services, Inc. Prepared for: Division & Crosby, LLC

Type of Document Submitted:

- [ ] Site Investigation Report - Comprehensive
- [ ] Site Investigation Report - Focused
- [ ] Remediation Objectives Report-Tier 1or 2
- [ ] Remediation Objectives Report-Tier 3
- [ ] Remedial Action Plan
- [x] Remedial Action Completion Report
- [ ] Sampling Plan
- [ ] Health and Safety Plan
- [ ] Community Relations Plan
- [ ] Risk Assessment
- [ ] Contaminant Fate & Transport Modeling
- [ ] Environmental Remediation Tax Credit - Budget Plan Review
- [ ] Other: _____

Document Title: _____ Date of Preparation of Plan or Report: _____

Prepared by: _____ Prepared for: _____

Type of Document Submitted:

- [ ] Site Investigation Report - Comprehensive
- [ ] Site Investigation Report - Focused
- [ ] Remediation Objectives Report-Tier 1or 2
- [ ] Remediation Objectives Report-Tier 3
- [ ] Remedial Action Plan
- [ ] Remedial Action Completion Report
- [ ] Sampling Plan
- [ ] Health and Safety Plan
- [ ] Community Relations Plan
- [ ] Risk Assessment
- [ ] Contaminant Fate & Transport Modeling
- [ ] Environmental Remediation Tax Credit - Budget Plan Review
- [ ] Other: _____

VI. Professional Engineer's or Geologist's Seal or Stamp:

I attest that all site investigations or remedial activities that are the subject of this plan(s) or report(s) were performed under my direction, and this document and all attachments were prepared under my direction or reviewed by me, and to the best of my knowledge and belief, the work described in the plan and report has been designed or completed in accordance with the Illinois Environmental Protection Act (415 ILCS 5), 35 Ill. Adm. Code 740, and generally accepted engineering practices or principles of professional geology, and the information presented is accurate and complete.

Engineer or Geologist Name: Jeffrey McClelland

Professional Engineer's or Geologist's Seal or Stamp:

Company: Pioneer Phone: 312.587.1021

Registration Number: 062-054039

Signature: _____ License Expiration Date: 11/30/2005

Note: The authority of a Licensed Professional Geologist to certify documents submitted to the Illinois Environmental Protection Agency for review and evaluation pursuant to Title XVII of the Environmental Protection Act is limited to Site Investigation Reports (415 ILCS 58.7(f), as amended by P.A. 92-0735, effective July 25, 2002). A Licensed Professional Geologist cannot certify Remediation Objectives Reports, Remedial Action Plans or Remedial Action Completion Reports.

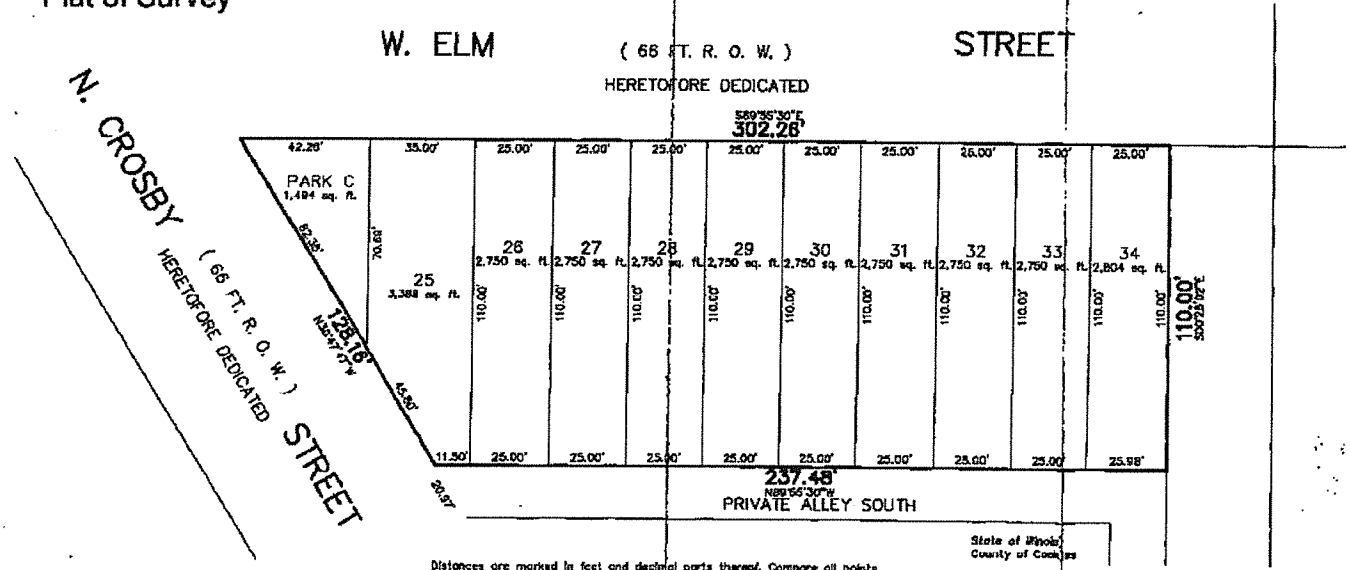
JEFFREY T. McCLELLAND
062-054039
LICENSED PROFESSIONAL ENGINEER
OF
ILLINOIS

GREMLEY & BIEDERMANN

License No. 184-002761
PROFESSIONAL LAND SURVEYORS
4505 North Elston Avenue, Chicago, IL 60630
Telephone: (773) 685-6102 Fax: (773) 286-4184 Email: INFO@PLCS-SURVEY.COM

Lots 25 to 34 and Lot Park C in Old Town Village West being a resubdivision of various lots and parts of vacated public alleys and part of vacated West Elm Street and vacated Chatham Court in Blocks 87 and 90 in Elston's Addition to Chicago, in Section 4, Township 39 North, Range 14, East of the Third Principal Meridian, in Cook County, Illinois.

Plat of Survey



REVISED 12/13/04 NO. 2004-02442 (BB)

ORDERED BY: NCL CONSTRUCTION CORP	CHECKED: JJ	DRAWN: [illegible]
ADDRESS: OLD TOWN VILLAGE WEST		

GREMLEY & BIEDERMANN

Licensed Professional Land Surveyors
4505 North Elston Avenue, Chicago, IL 60630
Telephone: (773) 685-6102 Fax: (773) 286-4184 Email: INFO@PLCS-SURVEY.COM

ORIGINAL: 2004-02261-001	DATE: JUNE 15, 2004 SCALE: 1 INCH = 50 FEET	SHEET NO. 1 OF 1

Distances are marked in feet and decimal parts thereof. Compare all points BEFORE building by same and at once report any differences BEFORE damage is done.

For easements, building lines and other restrictions not shown on survey plat refer to your abstract, deed, contract, title policy and local building line regulations.

NO dimensions shall be assumed by scale measurement upon this plat.

Monumentation or witness points were not set at the clients request.

Unless otherwise noted hereon the Bearing Basis, Elevation Datum and Coordinate Datum if used is ASSUMED.

COPYRIGHT GREMLEY & BIEDERMANN, INC. 2004 "All Rights Reserved"

State of Illinois
County of Cook, ss

We, GREMLEY & BIEDERMANN, INC. hereby certify that we have surveyed the above described property and that the plat hereon drawn is a correct representation of said survey corrected to a temperature of 62° Fahrenheit.

Field measurements completed on June 15, 2004.

Signed on 12-13-04

By: [signature]

Professional Illinois Land Surveyor No. 2477
My License Expires November 30, 2006
This professional service conforms to the current Illinois minimum standards for a boundary survey.

G. THOMAS GREEN
PROFESSIONAL LAND SURVEYOR
2477
CHICAGO, IL
STATE OF ILLINOIS

REMEDIAL ACTION COMPLETION REPORT

Remediation Site #4
Old Town Village West
Chicago, Illinois

Prepared For:

Division & Crosby, L.L.C.
455 East Illinois Street, Suite 565
Chicago, Illinois 60611
Attn: Mr. Rob Eshoo

ORIGINAL

Prepared By:

Pioneer Engineering & Environmental Services, Inc.
700 North Sacramento Blvd., Suite 101
Chicago, Illinois 60612

Report Date:

December 10, 2004

Pioneer Project No. 01466B

RELEASABLE
DEC 2 1 2004
REVIEWER MM

The following personnel have prepared and/or reviewed this report.

Michael Ciserella, P.E.
Vice President

Jeffrey McClelland, P.E.
Senior Project Manager

Pioneer Project Number: 01466B

Date: December 10, 2004

CONTENTS

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2.0 SOIL REMOVAL & ENGINEERED BARRIER CONSTRUCTION

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2.3 Engineered Barrier Installation 4

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Figure 1: Remediation Site #4
Figure 2: Engineered Barrier Layout - Remediation Site #4
Figure 3: Site Base Map

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Appendix A: Site Remediation Program Form DRM-2
Remediation Site #4 Plat of Survey and PINs
Appendix B: Waste Disposal Manifests
Appendix C: Photographic Log
Appendix D: Landscape Plan

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1.0 INTRODUCTION

Pioneer Engineering & Environmental Services, Inc. (Pioneer) was contracted by Division & Crosby, LLC (Client) to provide environmental consulting and Illinois EPA reporting services for the Old Town Village West (Remediation Site) redevelopment located in Chicago, Illinois (Appendix A; Figure 1). The purpose of this work was to obtain a Comprehensive No Further Remediation (NFR) Letter from the Illinois EPA as formal acknowledgment of site closure in accordance with the regulations set forth in Section 58.10 of the Illinois Environmental Protection Act.

The Remediation Site described within this report was initially part of a larger parcel that was entered into the Illinois EPA's Site Remediation Program (SRP) in May 2002 under Illinois Inventory I.D. Number 0316085389. The larger parcel included a triangular-shaped, 4.4-acre, undeveloped parcel of land located at the southwest corner of West Division and North Howe Streets, in Chicago, Illinois. For redevelopment purposes, the Remediation Site has been separated from the larger parcel to obtain a distinct comprehensive NFR Letter and will herein be referred to as Remediation Site #4. Remediation Site #4 is comprised of approximately 0.681 acres located in the south-central portion of the larger parcel, and is bounded to the north by a West Elm Street, to the east by a City of Chicago Police Department parking lot, to the south by a new public alleyway, and to the west by North Crosby Street. A Plat of Survey depicting Remediation Site #4 and the appropriate Illinois EPA SRP DRM-2 form are provided in Appendix A of this report.

Pioneer previously submitted a *Site Investigation Report-Comprehensive* (SIR-C), dated April 30, 2002, which included data collected for Remediation Site #4 as well as the larger parcel. Pioneer also submitted a *Remediation Objectives Report & Remedial Action Plan* (ROR/RAP), dated August 30, 2002. As described in these previous reports, Remediation Site #4, as well as the larger parcel, have been impacted from a combination of past operations and/or fill materials throughout the majority of the site. The primary contaminants detected above Tier 1 soil remediation objectives (SROs) for residential property use were polynuclear aromatic hydrocarbons (PNAs), arsenic and lead. An endangerment assessment was performed in accordance with the TACO (Tiered Approach to Corrective Action Objectives) regulations of 35 IAC 742 to address the detected contaminants.

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The results of the endangerment assessment indicated that the use of engineered barriers would be required to protect human health and the environment and allow the impacted soils to remain in-place at the site.

These reports were conditionally approved by the Illinois EPA in a letter, dated November 1, 2002. The conditions of the approval included (1) photographs be provided of the installation of the compacted clay engineered barriers in the landscaped areas; (2) landscaping plans for the site be provided; (3) documentation be provided that a three-foot layer of clean soil is located where each tree is planted and a two-foot layer is located where each shrub is planted; and (4) documentation be provided that all other engineered barriers are in-place in non-landscaped areas of the site.

The primary scope of Pioneer's recent environmental services included the verification and documentation of the installation of engineered barriers above impacted soil identified at Remediation Site #4; manifesting of contaminated soil excavated for redevelopment purposes and disposed of off-site; and the preparation and submittal of a *Remedial Action Completion Report* (RACR) to the Illinois EPA to support the issuance of a Comprehensive NFR letter. Subsequent RACRs will be submitted to the Illinois EPA to address the remaining areas of Old Town Village West, as phases of the redevelopment are completed. As a note, Remedial Action Completion Reports in this same format were previously submitted to the Agency, and No Further Remediation letters were subsequently issued for Remediation Sites #1, #2 and #3.

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2.0 SOIL REMOVAL & ENGINEERED BARRIER CONSTRUCTION

2.1 Introduction

Based on the information collected during Pioneer's subsurface investigation and the results of the risk assessment, the most practical and yet protective option for obtaining an NFR Letter for Remediation Site #4 was determined to be the pathway exclusion method in accordance with Subpart C of the Part 742 regulations. As previously mentioned, engineered barriers were chosen as the method of excluding the soil ingestion pathway. Additionally, some impacted soil excavation and off-site disposal was conducted for construction purposes and to accommodate the placement of engineered barriers.

2.2 Soil Removal

As mentioned, soil was excavated to accommodate the installation of engineered barriers. This excavation consisted primarily of the removal of the upper 1.5 feet of soil in landscaped areas associated with the residential structures to accommodate the one-foot thick compacted clay barrier as well as 6 inches of topsoil. In the areas of the parks, since the elevation was raised by up to two feet with compacted clay and topsoil, surficial soil was only removed as necessary to achieve the engineered barrier requirement. In addition, structurally unsuitable materials were excavated from areas of the building pads for construction purposes.

Prior to excavation, the impacted soil was classified as non-hazardous special waste based on the analytical and historical data obtained from the site. Permits were subsequently obtained for disposal at Onyx's landfill in Zion, Illinois. All impacted soils were transported to the landfill by licensed special waste haulers. As a result of the excavation activities, approximately 1,410 cubic yards of special waste soils were disposed of at the Onyx facility. Copies of the solid waste manifests are provided in Appendix B for review.

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2.3 Engineered Barrier Installation

In accordance with the Illinois EPA-approved ROR/RAP, in order to manage the residual contaminants in-place, engineered barriers were installed throughout Remediation Site #4 (Figure 2). The concrete floors/pads of the buildings, the concrete walkways, and the asphalt parking areas were used as one component of the engineered barrier. In unpaved, landscaped areas, a minimum of 12-inches of compacted clay was installed. Some of the planned trees and shrubs were also installed as stipulated by the Illinois EPA in their ROR/RAP approval letter, dated November 1, 2002. Due to inclement weather conditions, all landscaping could not be completed prior to the submittal of this RACR, however, documentation of the installation of the remaining landscaping will be provided to the Illinois EPA at a later date. These components of the engineered barrier overlap and effectively create one complete barrier that covers the entire site to adequately eliminate the soil ingestion pathway. Photo documentation showing various stages of the barrier installation process is included as Appendix C.

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3.0 FINDINGS

3.1 Summary

Pioneer was contracted by Division & Crosby, LLC to provide environmental consulting and Illinois EPA reporting services for the Old Town Village West development located in Chicago, Illinois (Appendix A; Figure 1). The primary scope of services included the verification and documentation of the installation of engineered barriers above impacted soil, and the preparation and submittal of a *Remedial Action Completion Report* to the Illinois EPA to support the issuance of a Comprehensive No Further Remediation Letter for Remediation Site #4. As noted, Remediation Site #4 includes only a portion of the larger Old Town Village West site (Figure 1). Subsequent RACRs will be submitted to the Illinois EPA to address the remaining areas, as phases of the development are completed.

The Agency-approved engineered barriers have been installed throughout Remediation Site #4 as part of the on-going residential development (Figure 2). The engineered barriers consist of (1) concrete floors/foundations of the buildings; (2) concrete walkways and asphalt parking areas; and (3) in unpaved, landscaped areas, a minimum of 12 inches of compacted clay. These components of the engineered barrier overlap and effectively create one complete barrier that covers the entire Remediation Site #4 to adequately eliminate the soil ingestion pathway.

3.2 Conclusions

Based on the results of the site investigations, remediation objectives determination and TACO endangerment assessment, and the installation of the engineered barriers throughout Remediation Site #4, Pioneer believes it has been sufficiently demonstrated that the risk associated with residual contamination at Remediation Site #4 can be adequately managed in-place and does not represent a significant threat to human health or the environment. Thus, Pioneer concludes that Remediation Site #4 warrants no further investigation and the issuance of a Comprehensive NFR Letter pursuant to 35 IAC Part 740.420 and 415 ILCS 5/58.10 as Agency acknowledgment of formal site closure.

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Pioneer respectfully requests the Comprehensive NFR Letter include the following conditions and institutional controls:

- there are no land use limitations;
- a Site Safety Plan must be developed if future excavation is performed in any areas where residual soil contamination exceeds construction worker Tier 1 SROs;
- the engineered barriers must remain over the residual contamination to prevent the ingestion of contaminated soil below the barriers. These barriers must be properly maintained in the future in accordance with the NFR Letter, which once recorded on the deed to the property, will act as an appropriate institutional control;
- any contaminated soil or groundwater that is removed, excavated, or disturbed from the subject property must be handled in accordance with applicable laws and regulations; and
- the NFR Letter shall be recorded as a permanent part of the chain of title for the subject property and serve as an appropriate institutional control.

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4.0 CLOSING REMARKS

This report has been prepared for evaluation by the Illinois EPA and for the sole use of the client identified in the report (Division & Crosby, LLC) and can not be relied upon by other persons or entities without the joint permission of the client and Pioneer Engineering & Environmental Services, Inc. (Pioneer). The observations and conclusions contained herein are limited by the scope and intent of the work mutually agreed upon by the client and Pioneer and the work actually performed. There are no warranties, implied or expressed, concerning the environmental integrity of areas and/or mediums not analytically tested.

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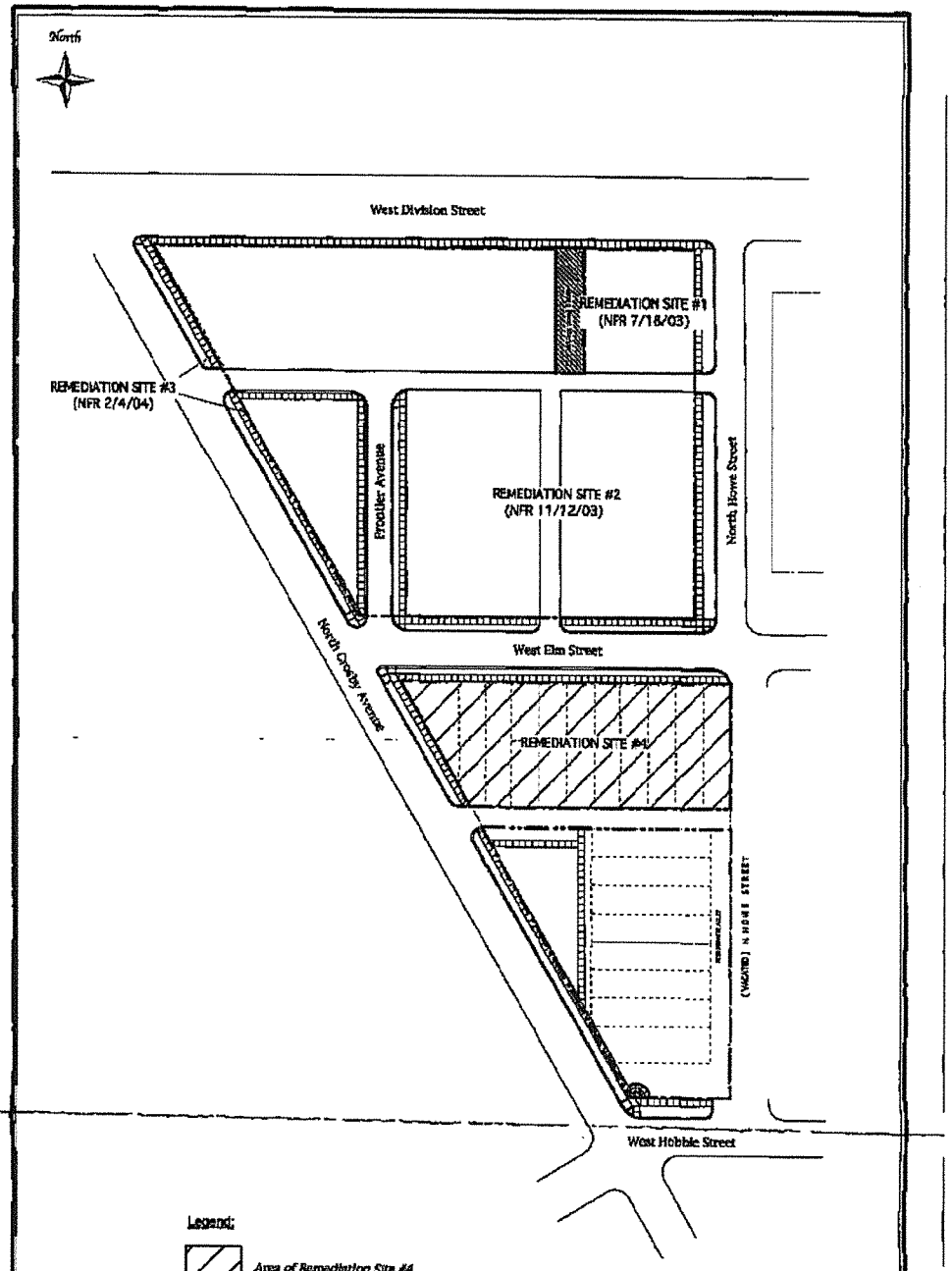
Figure 1: Remediation Site #4
Figure 2: Engineered Barrier Layout - Remediation Site #4
Figure 3: Site Base Map



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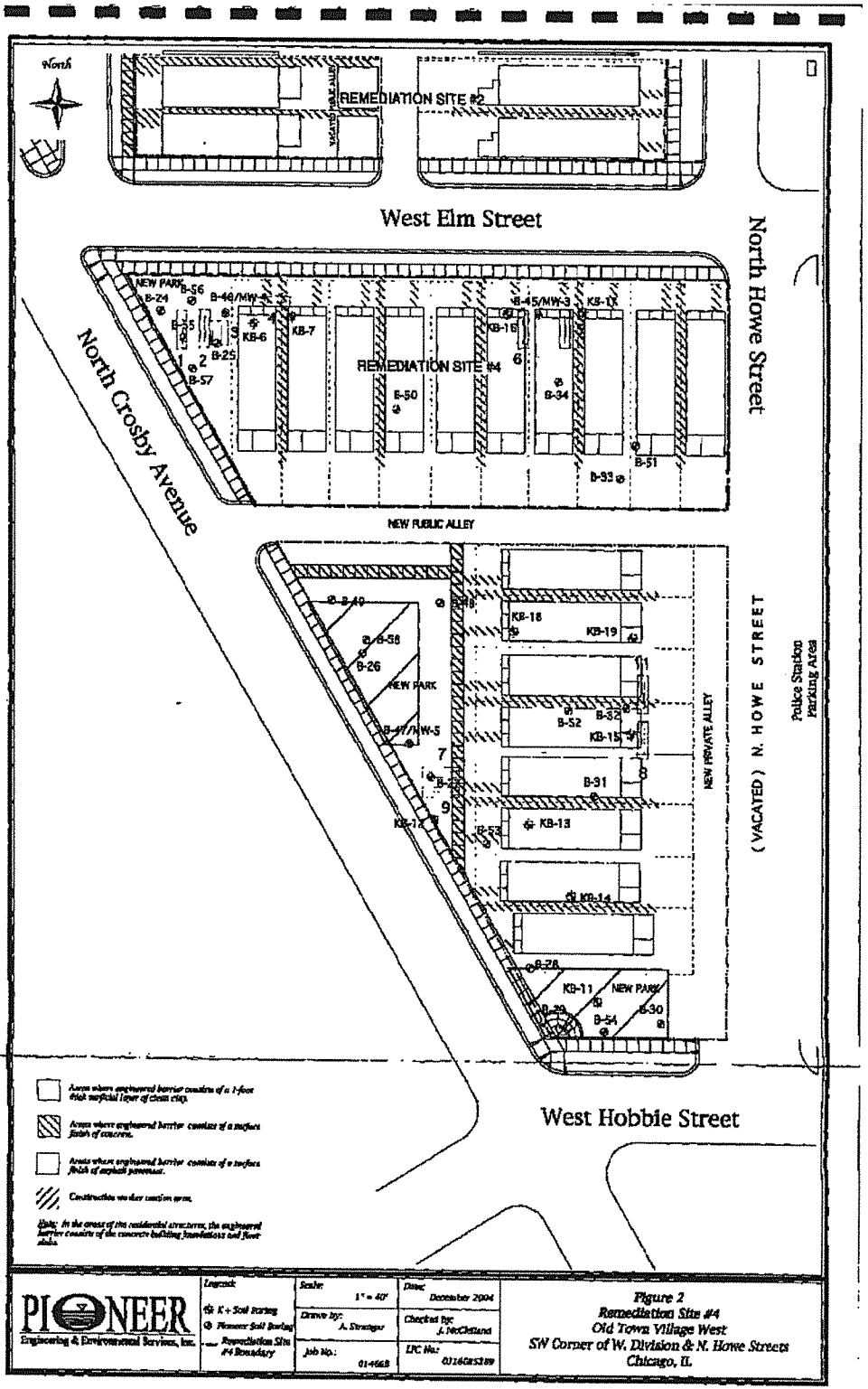

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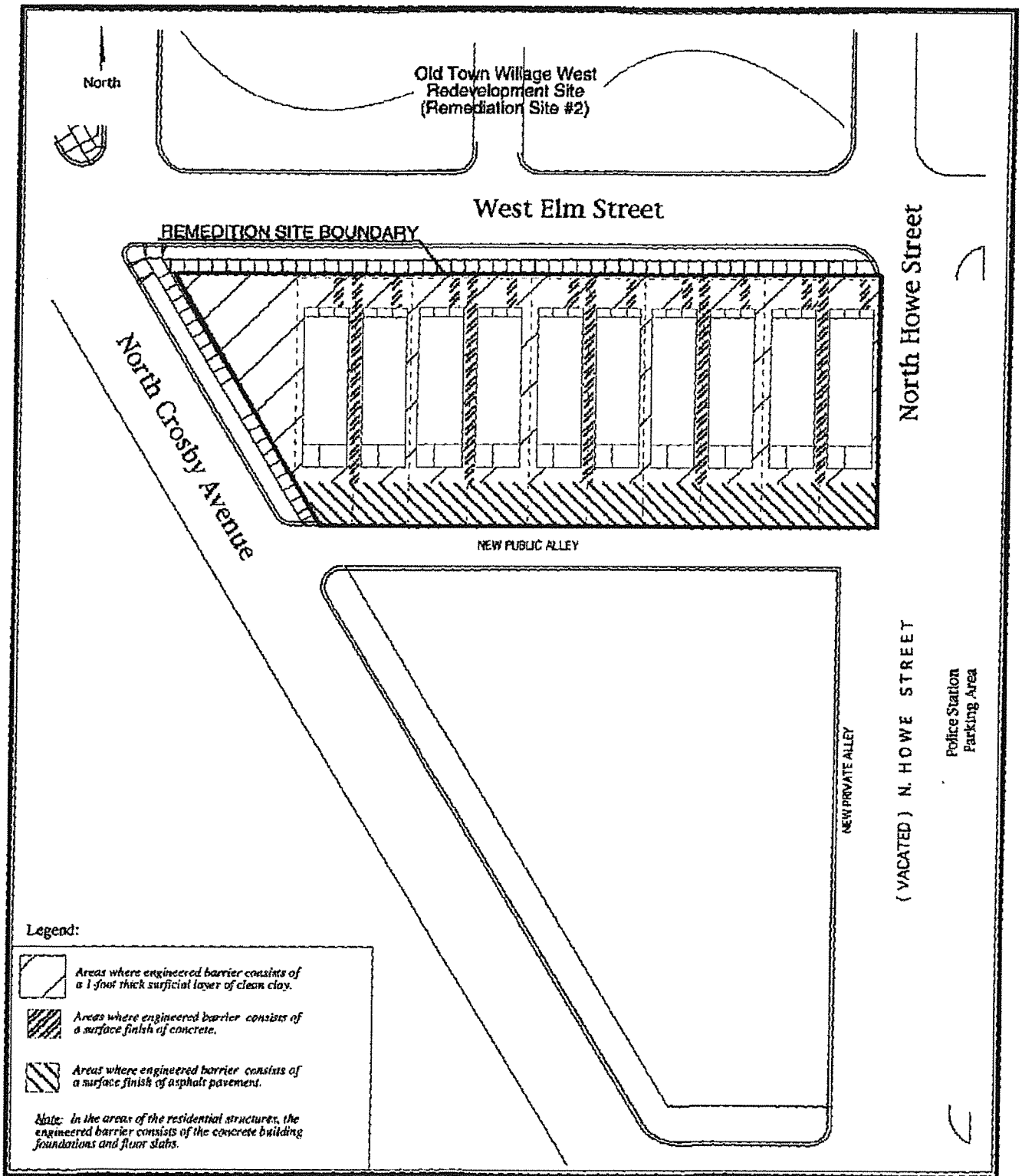
Site Base Map
0316085389-Cook County
Chicago/Old Town Village West
REMEDIATION SITE #4
Site Remediation Program



PIONEER Engineering & Environmental Services, Inc.	Scale: 1"= 60'	Date: December 2004	Site Base Map Remediation Site #4 Old Town Village West Chicago, Illinois
	Drawn by: A. Strangar	Checked by: J. McClelland	
	Job No.: 014668		

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I:00000032 EPA4247 06/20/2005 EPA4561 07/06/2010

05-24970

PIONEER Engineering & Environmental Services, Inc.

700 North Sacramento Boulevard, Suite 101 • Chicago, Illinois 60612
773.722.9200 • Fax: 773.722.9201
www.pioneerenvironmental.com

0316085389
Old Town Village West
SR/Tech

May 25, 2005

Illinois Environmental Protection Agency
Bureau of Land #24
Remedial Project Management Section
Site Remediation Program
1021 North Grand Ave. East
P.O. Box 19276
Springfield, IL 62794-9276
Attn.: Mr. Todd Hall

RECEIVED
MAY 27 2005
IEPA/BOL

RE: Remedial Action Completion Report
REMEDIATION SITE #5
0316085389 – Cook County
Chicago / Old Town Village West

Dear Mr. Hall:

Pioneer Engineering & Environmental Services, Inc. (Pioneer) is submitting three copies of a *Remedial Action Completion Report (RACR)*, dated May 23, 2005, and the associated DRM-2 form for the above referenced site. Please note that the Remediation Site described within this report was initially part of a larger parcel that was entered into the Illinois EPA's Site Remediation Program in May 2002. For redevelopment purposes, the Remediation Site has been separated from the larger parcel to obtain a distinct comprehensive NFR Letter and has been referred to as Remediation Site #5. Remediation Site #5 is comprised of approximately 0.855 acres located in the southern most portion of the larger 4.4-acre parcel. Please note that this report is the last one of a series of five RACRs completed and submitted to the Agency regarding the larger parcel entered into the SRP.

Due to timing constraints associated with pending sales of the residential units at this redevelopment site, Pioneer and the Remediation Applicant would appreciate any efforts to expedite your review of this project. Pioneer appreciates your time with this matter and thanks you in advance for your review of this information. Please contact me with any questions or comments at (773) 722-9200.

Respectfully submitted,
PIONEER ENGINEERING & ENVIRONMENTAL SERVICES, INC.

Jeffrey McClelland, P.E.
Senior Project Manager

Encl.

cc: Rob Eshoo, MCL Companies (w/Encl.)

RELEASABLE
MAY 31 2005
REVIEWER MD
ORIGINAL

REMEDIAL ACTION COMPLETION REPORT

Remediation Site #5
Old Town Village West
Chicago, Illinois

Prepared For:

Division & Crosby, L.L.C.
455 East Illinois Street, Suite 565
Chicago, Illinois 60611
Attn: Mr. Rob Eshoo

RECEIVED
MAY 2 7 2005
IEPA/BOL

Prepared By:

Pioneer Engineering & Environmental Services, Inc.
700 North Sacramento Blvd., Suite 101
Chicago, Illinois 60612

Report Date:

May 25, 2005

RELEASABLE
MAY 3 1 2005
REVIEWER MD
ORIGINAL

Pioneer Project No. 01466B

The following personnel have prepared and/or reviewed this report.

Jeffrey McClelland, P.E.
Senior Project Manager

Karen O. Hounsokou
Project Manager

Pioneer Project Number: 01466B

Date: May 25, 2005

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Remediation Site #5 Plats of Survey and PIN
Appendix B: Waste Disposal Manifests
Appendix C: Photographic Log
Appendix D: Landscape Plan

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1.0 INTRODUCTION

Pioneer Engineering & Environmental Services, Inc. (Pioneer) was contracted by Division & Crosby, LLC (Client) to provide environmental consulting and Illinois Environmental Protection Agency (IEPA) reporting services for the Old Town Village West (Remediation Site) redevelopment located in Chicago, Illinois (Appendix A; Figure 1). The purpose of this work was to obtain a Comprehensive No Further Remediation (NFR) Letter from the Illinois EPA as formal acknowledgment of site closure in accordance with the regulations set forth in Section 58.10 of the Illinois Environmental Protection Act.

The Remediation Site described within this report was initially part of a larger parcel that was entered into the Illinois EPA's Site Remediation Program (SRP) in May 2002 under Illinois Inventory I.D. Number 0316085389. The larger parcel included a triangular-shaped, 4.4-acre, undeveloped parcel of land located at the southwest corner of West Division and North Howe Streets, in Chicago, Illinois. For redevelopment purposes, the Remediation Site has been separated from the larger parcel to obtain a distinct comprehensive NFR Letter and will herein be referred to as Remediation Site #5. Remediation Site #5 is comprised of approximately 0.855 acres located in the southern most portion of the larger parcel. Remediation Site #5 is bounded to the north by a new private alleyway, to the east by (vacated) North Howe Street, to the south by West Hobbie Street and to the west by North Crosby Street. A Plat of Survey depicting Remediation Site #5 and the appropriate Illinois EPA SRP DRM-2 form are provided in Appendix A of this report.

Pioneer previously submitted a *Site Investigation Report-Comprehensive* (SIR-C), dated April 30, 2002, which included data collected for Remediation Site #5 as well as the larger parcel. Pioneer also submitted a *Remediation Objectives Report & Remedial Action Plan* (ROR/RAP), dated August 30, 2002. As described in these previous reports, Remediation Site #5, as well as the larger parcel, have been impacted from a combination of past operations and/or fill materials throughout the majority of the site. The primary contaminants detected above Tier 1 soil remediation objectives (SROs) for residential property use were polynuclear aromatic hydrocarbons (PNAs), arsenic and lead. An endangerment assessment was performed in accordance with the TACO (Tiered Approach to Corrective Action Objectives) regulations of 35 IAC 742 to address the detected contaminants.

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The results of the endangerment assessment indicated that the use of engineered barriers would be required to protect human health and the environment and allow the impacted soils to remain in-place at the site.

These reports were conditionally approved by the Illinois EPA in a letter, dated November 1, 2002. The conditions of the approval included (1) photographs be provided of the installation of the compacted clay engineered barriers in the landscaped areas; (2) landscaping plans for the site be provided; (3) documentation be provided that a three-foot layer of clean soil is located where each tree is planted and a two-foot layer is located where each shrub is planted; and (4) documentation be provided that all other engineered barriers are in-place in non-landscaped areas of the site.

The primary scope of Pioneer's recent environmental services included the verification and documentation of the installation of engineered barriers above impacted soil identified at Remediation Site #5; manifesting of contaminated soil excavated for redevelopment purposes and disposed of off-site; and the preparation and submittal of a *Remedial Action Completion Report* (RACR) to the Illinois EPA to support the issuance of a Comprehensive NFR letter. This RACR is the last one in a series of five RACRs submitted to the Illinois EPA regarding the larger Old Town Village West site. As a note, RACRs in this same format were previously submitted to the Agency, and No Further Remediation letters were subsequently issued for Remediation Sites #1, #2, #3 and #4.

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2.0 SOIL REMOVAL & ENGINEERED BARRIER CONSTRUCTION

2.1 Introduction

Based on the information collected during Pioneer's subsurface investigation and the results of the risk assessment, the most practical and yet protective option for obtaining an NFR Letter for Remediation Site #5 was determined to be the pathway exclusion method in accordance with Subpart C of the Part 742 regulations. As previously mentioned, engineered barriers were chosen as the method of excluding the soil ingestion pathway. Additionally, some impacted soil excavation and off-site disposal was conducted for construction purposes and to accommodate the placement of engineered barriers.

2.2 Soil Removal

As mentioned, soil was excavated to accommodate the installation of engineered barriers. This excavation consisted primarily of the removal of the upper 1.5 feet of soil in landscaped areas associated with the residential structures to accommodate the one-foot thick compacted clay barrier as well as 6 inches of topsoil. In the areas of the parks, since the elevation was raised by up to two feet with compacted clay and topsoil, surficial soil was only removed as necessary to achieve the engineered barrier requirement. In addition, structurally unsuitable materials were excavated from areas of the building pads for construction purposes.

Prior to excavation, the impacted soil was classified as non-hazardous special waste based on the analytical and historical data obtained from the site. Permits were subsequently obtained for disposal at Onyx's landfill in Zion, Illinois. All impacted soils were transported to the landfill by licensed special waste haulers. As a result of the excavation activities, approximately 975 cubic yards of special waste soils were disposed of at the Onyx facility. Copies of the solid waste manifests are provided in Appendix B for review.

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2.3 Engineered Barrier Installation

In accordance with the Illinois EPA-approved ROR/RAP, in order to manage the residual contaminants in-place, engineered barriers were installed throughout Remediation Site #5 (Figure 2). The concrete floors/pads of the buildings and the concrete walkways were used as one component of the engineered barrier. In unpaved, landscaped areas, a minimum of 12-inches of compacted clay was installed. Due to inclement weather conditions and scheduling constraints, all landscaping could not be completed prior to the submittal of this RACR. However, documentation of the installation of the remaining landscaping will be provided to the Illinois EPA at a later date. These components of the engineered barrier overlap and effectively create one complete barrier that covers the entire site to adequately eliminate the soil ingestion pathway. Photographic documentation showing various stages of the barrier installation process is included as Appendix C.

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3.0 FINDINGS

3.1 Summary

Pioneer was contracted by Division & Crosby, LLC to provide environmental consulting and Illinois EPA reporting services for the Old Town Village West development located in Chicago, Illinois (Appendix A; Figure 1). The primary scope of services included the verification and documentation of the installation of engineered barriers above impacted soil, and the preparation and submittal of a *Remedial Action Completion Report* to the Illinois EPA to support the issuance of a Comprehensive No Further Remediation Letter for Remediation Site #5. As noted, Remediation Site #5 includes only a portion of the larger Old Town Village West site (Figure 1). Remediation Site #5 is the last of the five Remediation Sites to be developed and therefore this RACR is the last in a series of five RACRs submitted to the Illinois EPA regarding the larger Old Town Village West site.

The Agency-approved engineered barriers have been installed throughout Remediation Site #5 as part of the on-going residential development (Figure 2). The engineered barriers consist of (1) concrete floors/foundations of the buildings; (2) concrete walkways; and (3) in unpaved, landscaped areas, a minimum of 12 inches of compacted clay. These components of the engineered barrier overlap and effectively create one complete barrier that covers the entire Remediation Site #5 to adequately eliminate the soil ingestion pathway.

3.2 Conclusions

Based on the results of the site investigations, remediation objectives determination and TACO endangerment assessment, and the installation of the engineered barriers throughout Remediation Site #5, Pioneer believes it has been sufficiently demonstrated that the risk associated with residual contamination at Remediation Site #5 can be adequately managed in-place and does not represent a significant threat to human health or the environment. Thus, Pioneer concludes that Remediation Site #5 warrants no further investigation and the issuance of a Comprehensive NFR Letter pursuant to 35 IAC Part 740.420 and 415 ILCS 5/58.10 as Agency acknowledgment of formal site closure.

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Pioneer respectfully requests the Comprehensive NFR Letter include the following conditions and institutional controls:

- there are no land use limitations;
- a Site Safety Plan must be developed if future excavation is performed in any areas where residual soil contamination exceeds construction worker Tier 1 SROs;
- the engineered barriers must remain over the residual contamination to prevent the ingestion of contaminated soil below the barriers. These barriers must be properly maintained in the future in accordance with the NFR Letter, which once recorded on the deed to the property, will act as an appropriate institutional control;
- any contaminated soil or groundwater that is removed, excavated, or disturbed from the subject property must be handled in accordance with applicable laws and regulations; and;
- the NFR Letter shall be recorded as a permanent part of the chain of title for the subject property and serve as an appropriate institutional control.

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4.0 CLOSING REMARKS

This report has been prepared for evaluation by the Illinois EPA and for the sole use of the client identified in the report (Division & Crosby, LLC) and can not be relied upon by other persons or entities without the joint permission of the client and Pioneer Engineering & Environmental Services, Inc. (Pioneer). The observations and conclusions contained herein are limited by the scope and intent of the work mutually agreed upon by the client and Pioneer and the work actually performed. There are no warranties, implied or expressed, concerning the environmental integrity of areas and/or mediums not analytically tested.

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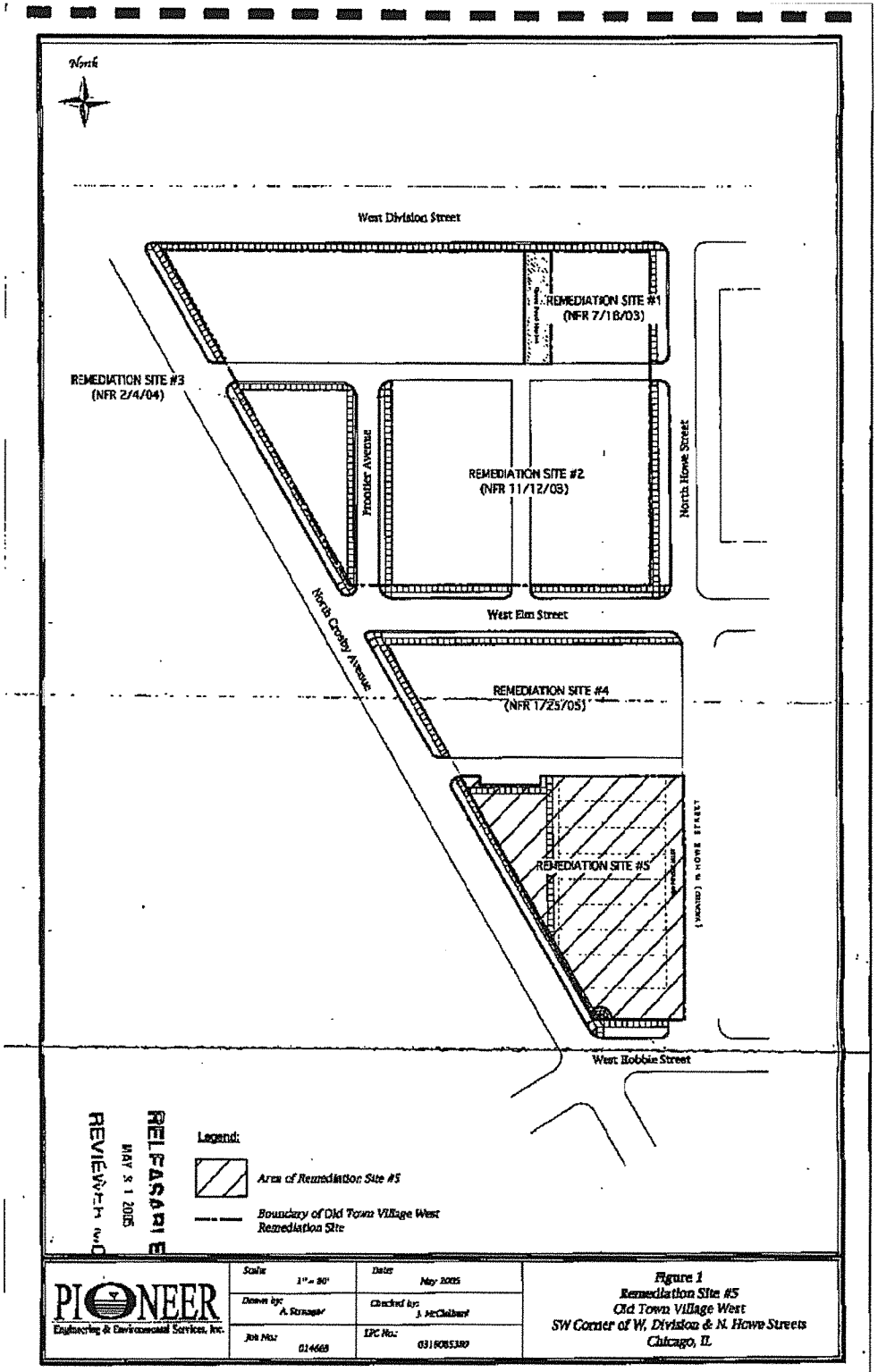

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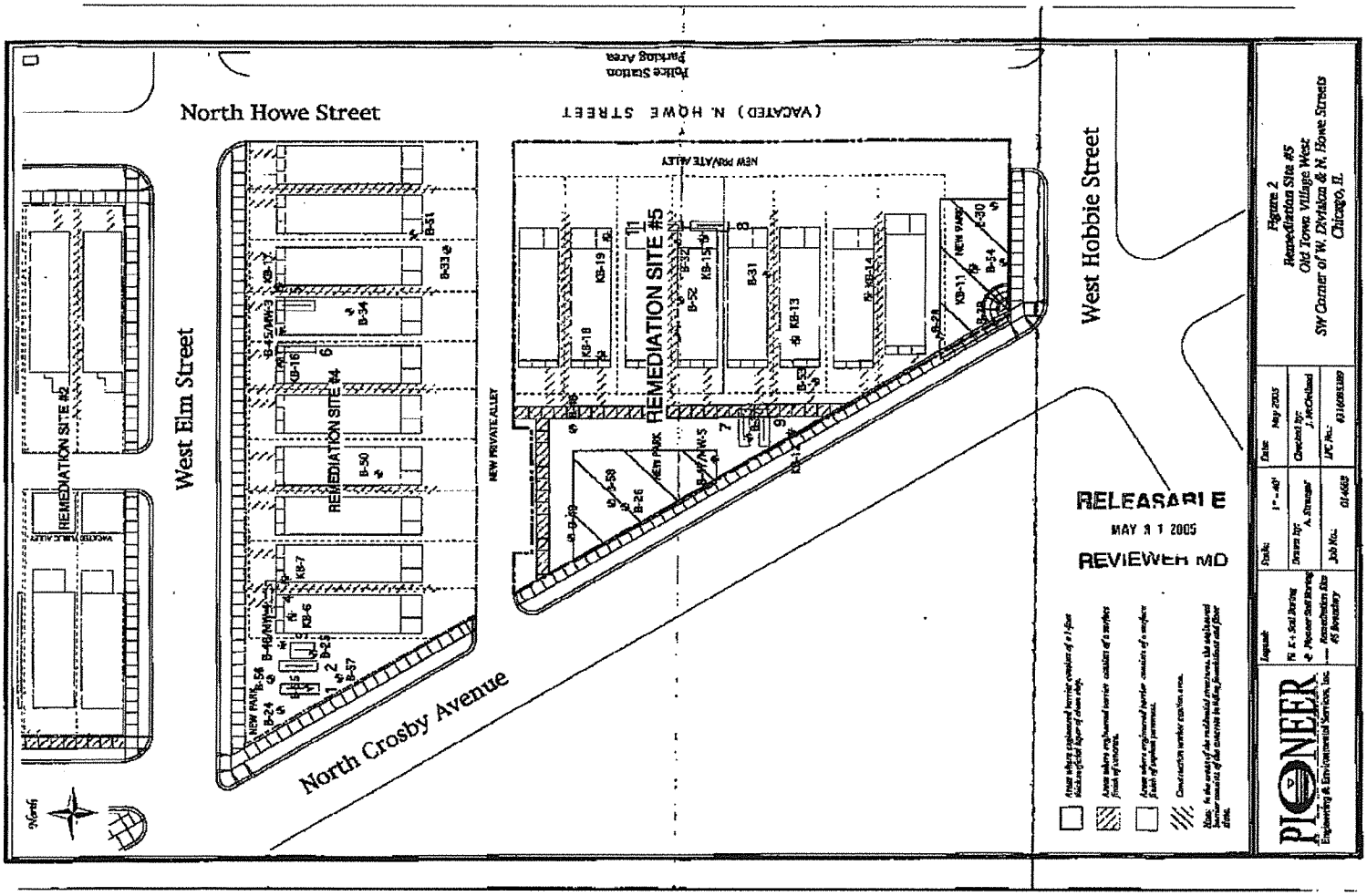
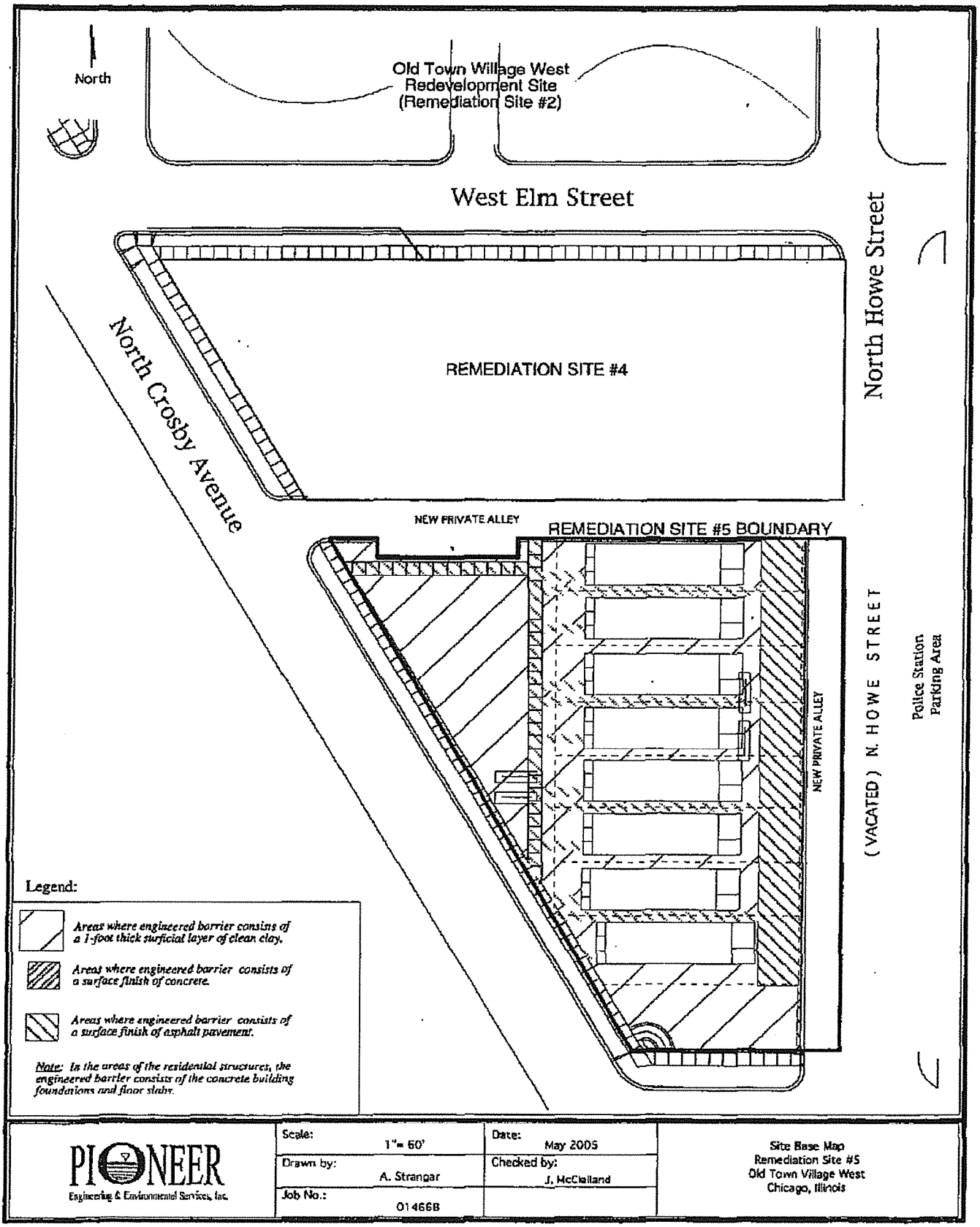

North Howe Street
West Elm Street
North Crosby Avenue
West Hobbie Street
(VACATED) N. HOWE STREET
Police Station Parking Area
NEW PRIVATE ALLEY
REMEDIATION SITE #2
REMEDIATION SITE #4
REMEDIATION SITE #5
RELEASABLE
MAY 31 2005
REVIEWER MD
Figure 2
Remediation Site #5
Old Town Village West
SW Corner of W. Division & N. Howe Streets
Chicago, IL
PIONEER
Engineering & Environmental Services, Inc.

Site Base Map
0316085389-Cook County
Chicago/Old Town Village West
REMEDIATION SITE #5
Site Remediation Program



PIONEER Engineering & Environmental Services, Inc.	Scale: 1"= 60'	Date: May 2005	Site Base Map Remediation Site #5 Old Town Village West Chicago, Illinois
	Drawn by: A. Strangar	Checked by: J. McClelland	
	Job No.: 01466B		